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A Life-saving but Inadequately Discussed Procedure: Tube Duodenostomy. Known and Unknown Aspects

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Abstract
Objective The most successful method of managing the difficult duodenum, including the stump leakage, has been the tube duodenostomy technique, but it has not gained wide acceptance and is rarely used. The purpose of this study is to describe the details of the procedure for indication, technical approach, and postoperative care.
Methods During the period from 1998 to 2006, a tube duodenostomy was performed in 31 patients for possible insecure duodenal stump closure during gastric resection, postoperative duodenal stump leakage, duodenal leak after primary closure of duodenum for perforation or injury, or anostomotic leak after choledochoduodenostomy. All of the tube duodenostomies were performed through the open end of the duodenum. We also inserted a T-tube into the common bile duct in 19 of 31 patients (61.2 %) with tube duodenostomy.
Results A tube duodenostomy was performed in the primary operation in 15 of 31 patients. None of those 15 patients required a second operation, and there were no leaks and no deaths. Among the larger group (31 patients), there was one (3.2 %) duodenal stump leak after tube duodenostomy, and it ceased spontaneously; one patient had a subhepatic collection after removal of the duodenostomy tube, and three patients had associated incisional infections. Two patients died; one after a myocardial infarction and the other from irreversible sepsis. The mean length of hospital stay was 26.9 days.
Conclusions We conclude that tube duodenostomy is a simple, effective, and safe method to prevent rupture of an insecure duodenal stump or to treat the leakage from the duodenal stump or primary repair on the duodenum.

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The most dreaded technical complication of gastric resection has been leakage from the duodenal stump. Duodenal stump closure carries a leak rate of 1%–3 % in collected series [1–6]. The mortality rate from this complication is distressingly as high as 50% in early reviews [1–5, 7, 8]. Although advances in supportive care have reduced the mortality rates to 0%–12 % in recent studies [6, 9, 10], duodenal stump leakage still remains one of the most feared complications of gastric resection. The most successful method of managing the difficult duodenum has been the tube duodenostomy (TD) technique, which has been effectively used and reported by many surgeons [11–20]. It is surprising that, despite the good results reported with this technique [11–14, 18–20], it has not gained wide acceptance and is rarely used. Tube duodenostomy has been generally used when surgical closure of the inflamed or scarred duodenum from chronic ulcer is not safe in gastric resections done for peptic ulcer or when a duodenal stump leakage has occurred after duodenal closure in any operation. But surgery for peptic ulcer disease has gone through a period of significant change over the last quarter of twentieth century and into the twenty-first century. The incidence of peptic ulcer disease was on decline even prior to introduction of H_2 receptor antagonists in 1977, and the decline in the number of patients hospitalized for uncomplicated peptic ulcer disease has continued since that time [21]. Today, most operations performed for ulcer

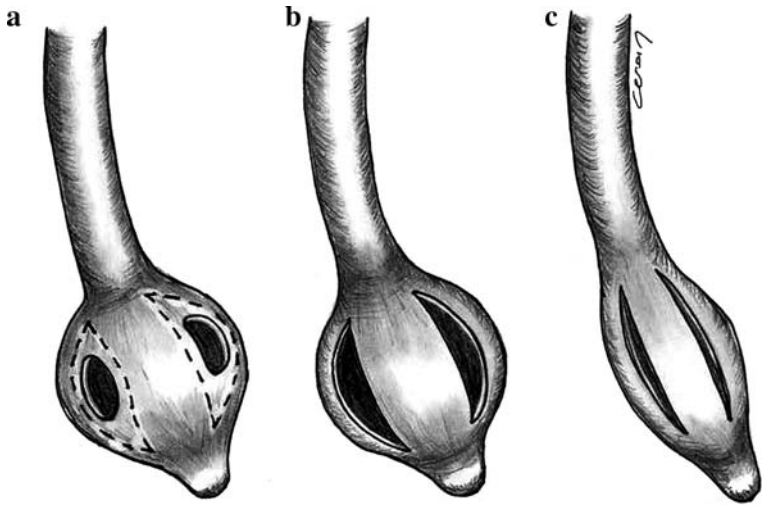

Fig. 1 Preparation of the Pezzer catheter before its insertion into the duodenal stump. **a.** Original appearance of the tube. Dotted lines around the holes on the head of the tube show the area to be cut. **b.** Final appearance of the tube before inserting to the duodenum, **c.** Appearance of the tube while removing. Note less traumatic effect of the tube to the duodenal stump

disease are for complications such as hemorrhage, perforation, or obstruction. The surgical procedures performed in these cases have also changed over time. The use of vagotomy and drainage and the development of the highly selective vagotomy have reduced the number of gastric resections performed for ulcer disease and hence reduced the need to contend with the difficult duodenal closure [9, 21–23]. Despite these developments, a TD still may be needed occasionally in these benign disorders. In addition there have been several reports advocating the benefits of aggressive surgery, even for advanced gastric cancers [24–26]. A TD may also absolutely be needed in the palliative resective procedures for advanced gastric malignancy. In addition, more excessive duodenum resection can be performed with curative intention instead of pancreaticoduodenectomy in gastric cancers with duodenal microinvasion, and performing a TD becomes inevitable [27, 28]. In the same way, TD has been successfully used in some of complicated duodenal injuries [29, 30].

Generally, the reason that abdominal surgeons avoid a TD may relate to the lack of published details about the indications for the procedure, the surgical technique, and the ideal postoperative care of the patient. However, a few articles mention results associated with the use of TD, whether good or bad [6, 19, 20, 31, 32]. Because there are no contemporary data on this subject, the procedure needs critical appraisal with large patient groups. The purpose of this study was to describe the details of the procedure for indication, technique, and postoperative care. In it we emphasized elucidative cornerstones of TDs performed by a single surgical team in the treatment of insecure duodenal stump closure or postoperative duodenal leakage.

Materials and methods

During the period from January 1998 to June 2006, 230 patients with complicated peptic ulcer, malignancy, or trauma were treated with gastrectomy in our institute. In this period, a TD was performed in 31 patients for possible insecure duodenal stump closure during the gastric resection, postoperative duodenal stump leakage after gastric resection, duodenal leak after primary closure for perforation or injury, or anastomotic leak after choledochoduodenostomy. The medical records of all patients were analyzed retrospectively. Each of these cases has been reviewed in detail for evidence of problems related to the dissection or to the closure of the duodenum. The clinical courses with respect to morbidity and mortality were reviewed. Especially, the postoperative course regarding TD has been detailed. These patients were then followed until death or the surviving patients have been reviewed within 3 months of the completion of this article (August 2006).

The technique of tube duodenostomy

All TDs were performed through the open end of the duodenum. An elastic, soft Pezzer catheter (French 22), was introduced through the stump of the duodenum to a depth of about 4–5 cm. Before introducing the Pezzer catheter, we widened the holes on the tip longitudinally and transversely (Fig. 1a) for better drainage of duodenal contents (Fig. 1b). Additionally, removal of the catheter would be as non-traumatic as possible (Fig. 1c). A pursestring of 3/0 absorbable suture was placed and tied so that it gently held the tube in place. The pursestring suture was invaginated into the lumen of the duodenum in the manner used in a Stamm gastrostomy [33] (Fig. 2a). In a few cases the duodenal stump by the catheter was inverted by Gambee sutures [34]. No matter which suturing technique was used, a duodenostomy catheter was fixed by the same technique. To establish whether there were any leaks from the duodenal stump that needed repair, we then injected 50 cc saline via the tube into the duodenum. Additional sutures were applied in these cases. A viable omental pedicle was then

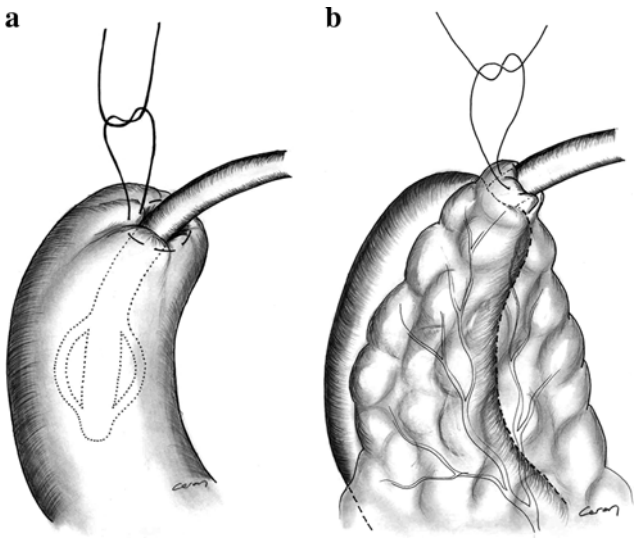

Fig. 2 **a.** Tube duodenostomy through the duodenal stump. **b.** The duodenal stump with Pezzer drain in it has been protected by surrounding omentum

secured around the junction of the tube and the duodenum (Fig. 2b). The tube was then brought out through the abdominal wall, just below the right costal margin, and secured to the skin. We tried to make this opening in the abdominal wall slightly lower than the level of duodenal stump, leaving the intraperitoneal portion of the tube as short as possible. But at the same time an effort was made not to stretch the tube between its fixation points, both at the stump and the skin, to protect it from being dislodged during increased abdominal pressure. A closed suction drain (Jackson-Pratt) was left near the TD. If a TD was applied for duodenal leakage in the secondary operation, or if TD and T-tube drainage of the common bile duct were performed together in the primary operation, closed suction drains were left both anterior to and posterior to the TD. In all the cases, contrast material was given through catheter a few days before removal of the TD in order to establish if there was a leak around the catheter (Fig. 3). We found that a TD should remain in place for about 21 days. Maturation of the tube tract that occurs at the end of 3 weeks allows safe drainage of the duodenal opening without intra-abdominal spillage after removal of the TD [35].

Sometimes we observed drainage of a small amount of duodenal content which ceased spontaneously after a few days. Although no leak was seen in the images obtained through the TD, we performed abdominal sonography at 1 and 3 day after removal of the TD because of the risk of intra-abdominal spillage of the duodenal content. Jackson-Pratt drain/s was/were withdrawn a few days after removal of TD if no duodenal content was noted.

We preferred adding T-tube drainage of the common bile duct to TD in the following situations: (1) when it was not possible to invert the TD with pursestring sutures satisfactorily or when there was a high probability of leakage from the side of the TD; (2) when a gastrectomy with curative intent was performed for gastric carcinoma with duodenal invasion, requiring a duodenal resection longer than 2–3 cm (because the pursestring sutures of TD may cause edema and partial obstruction of the distal common bile duct as a result of the close anatomic relationship); (3) when a secondary operation or tertiary operation was required.

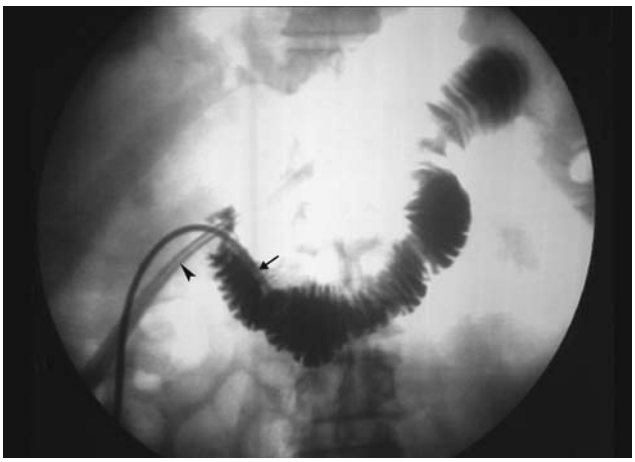

Fig. 3 Contrast graph through tube duodenostomy (Jacksonn-Pratt drain, arrowhead; tube duodenostomy, arrow)

The technique of T-tube drainage of the common bile duct that we have used is as described elsewhere [36]. Until the time of the removal of the TD, the T-tube in the common bile duct was not clamped intermittently or permanently. On the 20th postoperative day a cholangiogram with duodenal imaging scans were performed. The T-tube was removed a few days after removal of TD, but before removal of Jackson-Pratt drains (Fig. 4).

The outputs of TD, T-tube, and Jackson-Pratt drains were recorded daily. When two Jackson-Pratt drains were placed, the total daily output of both was calculated. Additionally, we evaluated the amylase concentration in the content of Jackson-Pratt drain/s to document duodenal leakage. Duodenal fistula was defined as the drainage (more than 50 cc/day) of amylase-rich drainage fluid (greater than 5 times the upper limit of normal for serum amylase) after day 7, like a pancreatic fistula [37].

Results

Between January 1998 and June 2006, TD was performed in 31 patients. There were 26 men and five women 20–73 years of age (mean: 49.2 years). Table 1 summarizes indications for operation of these patients. Table 2 presents underlying pathologies of the patients in whom TDs were

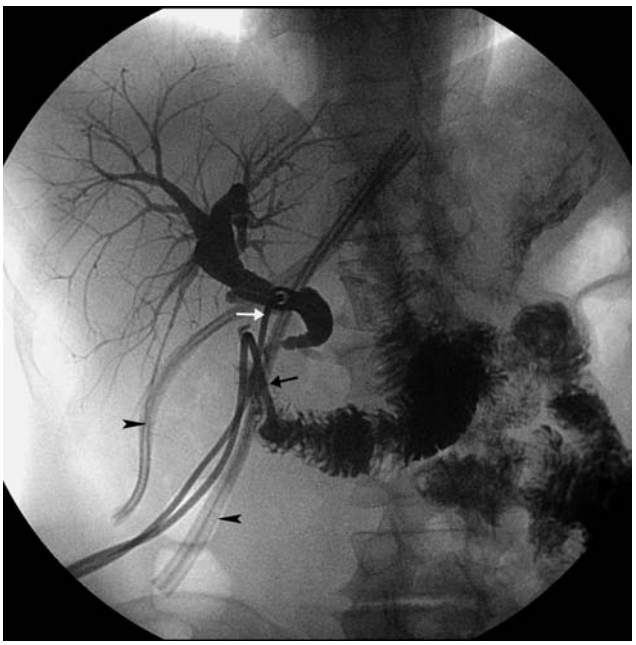

Fig. 4 Contrast imaging scans through tube duodenostomy and T-tube (Jacksonn-Pratt drains, arrowheads; tube duodenostomy, black arrow; T-tube, white arrow)

Table 1 Operation indications for tube duodenostomy in 31 patients

Indication	n
Duodenal ulcer	
Perforation	5
Bleeding	8
Obstruction	6
Gastric malignancy	7
Trauma	3
Leak after CD	2
Total	31

CD choledochoduodenostomy

performed for insecure duodenal closure. Table 3 presents underlying pathologies and primary and secondary operations of the patients in whom TDs were performed for postoperative leakage.

The output of TD, by considering the mean of daily values of all patients, was high from postoperative day 1 to postoperative day 7 (from 70 cc to 406 cc) and decreased gradually until postoperative day 21 (<200 cc). However, there was a reverse proportion between outputs of tube duodenostomy and T-tube. The outputs of TD, T-tube, and Jackson-Pratt drains are presented in Figure 5.

There was one (3.2 %) duodenal stump leak that fulfilled our duodenal leak criteria after the TD was performed. In this patient, TD was performed for duodenal leak from pyloroplasty after a bleeding duodenal ulcer. He had multiple operations previously for gunshot injury. This patient did not require an additional laparotomy, and the leak ceased spontaneously on postoperative day 9.

The other postoperative complications were few. One patient had a subhepatic collection after removal of the duodenostomy tube on postoperative day 21. The situation was noticed in routine abdominal ultrasonographic controls and treated with percutaneous drainage. Three patients had an associated insicional infection, treated with conservative means.

Two deaths occurred. The mortality rate was 6.4 % in this series. One patient died of a myocardial infarction on postoperative day 2. The patient had undergone truncal vagotomy and antrectomy with TD because of duodenal leak after closure for perforated duodenal ulcer. The other patient had a gunshot injury and had undergone subtotal gastrectomy and Roux-en-Y gastrojejunostomy in another hospital. Subsequently re-gastrojejunostomy was performed because of anostomotic leakage. The patient was referred to our center because of anostomotic leakage for the second time. During the operation, leaks from the duodenal stump and anostomotic site were established, and re-gastrojejunostomy with TD and T-tube drainage of the common bile duct were performed. It is likely there was a leak from the stump that was missed during the second operation. The patient died 16 days after the last operation as a result of sepsis. At the time of his death there was no duodenal leak.

A TD was performed in 15 of 31 patients in the primary operation. None of the 15 patients required a second operation, and there were no leaks and no deaths. The patients with associated mortality and morbidity were those in whom a TD was performed at reoperation.

T-tube drainage of the common bile duct was performed in 19 patients with TD. No complication was seen in association with this adjunct procedure.

The mean length of hospital stay in surviving patients was 26.9 (range: 21–58) days. Nineteen patients with complicated duodenal ulcer and surviving were followed for a mean of 34.2 months. No complications regarding TD or T-tube drainage of the common bile duct were noted. Four of eight patients with malignancy, including pancreatic head carcinoma, died during the follow-up period. Survival for patients with palliative subtotal gastrectomy (T_3, N_3, M_1) was 5 and 6 months; for those with total gastrectomy with curative intent (T_3, N_2, M_0), 13 months; for pancreatic head carcinoma (T_4, N_1, M_0), 6 months . One patient with palliative subtotal gastrectomy (T_3, N_2, M_1) is still alive 5 months later. Another three patients with gastric carcinoma revealing duodenal microinvasion or macroscopic extension beyond the pylorus (T_3, N_2, M_0) are still alive at 6, 20, and 22 months. Two patients with gunshot wounds who survived were followed for 60 and 68.5 months with no complications.

Table 2 Tube duodenostomy (TD) for insecure duodenal closure

Disease	n	Indication for TD	Procedure with TD	No of T-tube
Bleeding DU	6	Large defect, large size, full-thickness penetration, inflammatory edema	Vagotomy, antrectomy	2
Obstructed DU	4	Large size, full-thickness penetration, inflammatory edema, stenosing ulcer	Vagotomy, antrectomy	4
	2[a]		Vagotomy, gastrojejunostomy	
Gastric cancer ''curative''	4[b]	Extended duodenal resection to achieve tumor-free distal surgical border	Total or subtotal gastrectomy	2
Gastric cancer ''palliative''	3	Duodenal infiltration did not permit secure duodenal stump closure	Subtotal gastrectomy	2

[a] Antrectomy with TD was performed at reoperation in two cases because of delayed gastric emptying

[b] Duodenal stump resections were performed at reoperation in two cases

DU duodenal ulcer

Table 3 Tube duodenostomy for postoperative leakage

Disease	n	Primary procedure	Procedure with TD	No of T-tube
Perforated DU	4	Primary closure	Vagotomy, antrectomy	2
Perforated DU	1	Vagotomy, antrectomy	Only TD	1
Bleeding DU	1	Vagotomy, antrectomy	Only TD	1
Bleedig DU	1	Vagotomy, pyloroplasty	Antrectomy	1
Choledocholithiasis or palliation for pancreatic head cancer	2	Choledocoduodenostomy	Antrectomy, hepaticojejunostomy	1
Trauma	1	Primary closure of duodenum, T-tube	Vagotomy, antrectomy, hepaticojejunostomy	1
Trauma	1	Choledocoduodenostomy	Vagotomy, antrectomy, hepaticojejunostomy	1
Trauma	1	Subtotal gastrectomy, right hemicolectomy, ileostomy	Re-gastrojejunostomy[a]	1

[a] Regastrojejunostomy with TD was performed in tertiary operation of this case

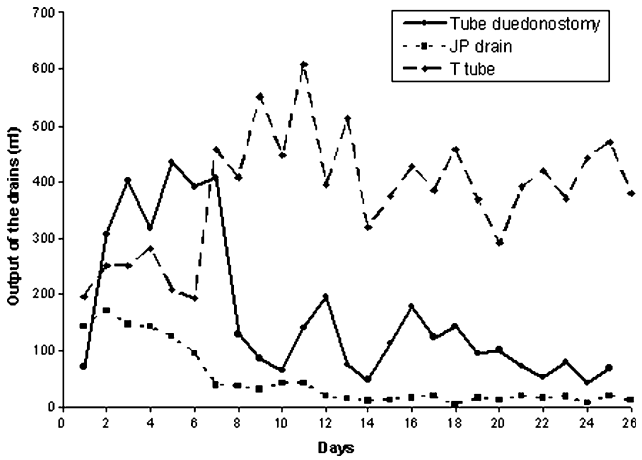

Fig. 5 Comparison of mean daily outputs of the tube duodenostomy, the T-tube in the common bile duct, and Jacksonn-Pratt drain near the tube duodenostomy

Discussion

Duodenal stump leak after gastric resection occurs only in 1%–3% of patients, and that figure includes elective procedures for peptic ulcer [1–6]. The probability of duodenal re-leakage after the reoperations done for duodenal stump leakage or duodenal leak after primary closure for injury is fairly high. Twelve of 31 patients (38.7 %) in this series had such emergency conditions due to duodenal leak, as presented in Table 3. Owing to TD, only one of 12 patients (8.33 %) had repeat duodenal leakage after the reoperation, whereas there was no leakage in 15 cases in which TD was performed in the primary operation. Duodenal leak from the side of the TD spontaneously ceased in this patient by postoperative day 9. Tube duodenostomy was also performed at the reoperations of four cases for delayed gastric emptying ($n = 2$) and duodenal microinvasion ($n = 2$).

Table 4 Results of surgical procedures used to prevent or treat leakage from the duodenal stump

Author	Technique	No. of patients	Mortality	Leak
Wu et al. [38]	TD with omental patch	12	None	8 spontaneously stopped duodenal leaks
Rodkey [31]	Side TD	73	10	17 leaks or intra-abdominal abscesses
	TD	12	1	3 leaks or intra-abdominal abscesses
	Intramural antral dissection and gastroduodenostomy	61	1	1 gastric leak following gastrostomy tube removal
Prigouris and Michas [19]	TD	71	1	None
Burch et al. [6]	Nissen's closure	25	None	None
	Bancroft's closure	6	None	None
	TD	9	1	3 duodenal leaks
Lippert and Coleman [14]	TD	21	None	1 duodenal leak
Mayfield and Abramson [13]	TD	5	Not mentioned	Not mentioned
Isik et al. [present study]	TD	31	2	1 leak and 1 intra-abdominal abscesses

In the series reported by Millat et al. [9], 8 of 60 patients (13.3%) undergoing emergency gastrectomy for bleeding ulcer developed a duodenal leak, and the mortality rate was 50%. In our series, which included complicated cases like duodenal stump leakage, the incidence of duodenal leak was 3.2%, and in no case was reoperation necessary. Our favorable results may be explained by TD.

A number of different surgical procedures and results have been used to prevent or treat leakage from the duodenal stump (Table 4). Nissen's closure, Bancroft's closure, and Wu's TD technique with omental patch and TD are the most popular procedures [6, 32, 38]. The duodenum of 19 patients with ulcer in our series was grossly deformed, with scarring, stenosis, edema, and fixation. In our opinion, suturing the ulcer edge to the duodenum anterior wall, as described in Nissen's closure [6], in the case of a large, deep posterior duodenal ulcer will invariably invite duodenal stump leakage.

Bancroft's closure employs distal antral submucosal dissection and has been recommended for situations in which inflammation and scarring prevent adequate dissection around the pylorus [33]. Essentially, Nissen's and Bancroft's closure techniques have been forgotten or abandoned today. Few contemporary data on these closure techniques are available [6, 32].

The most successful method of managing the difficult duodenum has been the TD technique. But published series about TD had either few patients or insufficient information related to indication, technique, and postoperative care [11–20]. We think a leak rate of 33% after TD in the study by Burch et al. [6] was disappointing and surprising. A study by Prigouris and Michas [19] found that in 71 patients with gastric resection and TD, there were no complications or leakage, which led the authors to conclude that end duodenostomy was a simple, effective, and safe measure for the prevention of postgastrectomy duodenal stump leakage. However, the article included only technical aspects of the procedure; other details, like the indications and postoperative course, were missing. Wu et al. [38] reported a modified surgical technique involving a TD placed through the duodenal stump enveloped around an omental patch. Although duodenal leak was frequent postoperatively they did not persist for long time.

A gastric resection was performed in the first operation in 12 patients with complicated duodenal ulcer. Performing aggressive procedures instead of more conservative ones such as drainage operations may be questioned. For the perforated duodenal ulcer, gastric resection was performed because the ulcer was too large for simple closure and the patient was stable during the operation [39]. In the cases of bleeding or obstructed duodenal ulcer, resection was performed because of large size, full-thickness penetration, location in large portion of the duodenal bulb, inflammatory edema, and stenosis of the ulcer involving both the anterior and posterior walls. Under such conditions, pyloroplasty could be hazardous; oversewing could lead to early and late rebleeding. Gastrojejunostomy could be associated with delayed gastric emptying because the stomach had extreme dilatation due to decompansated muscular layer just as occurred in two of our cases. Therefore, partial gastrectomy was performed in such conditions, as recommended by several authors [39–42].

The choice of the site for introduction of the catheter, either through the lateral wall of the duodenum or the duodenal stump, is of great importance in duodenostomy. Conceptually, these two techniques differ. Lateral duodenostomy or placement of the tube through the lateral wall of the second portion of the duodenum is primarily used for intraluminal decompression [41, 43–46]. Additionally, some surgeons have criticized placing a duodenostomy tube through chronically scarred tissue, believing that this would certainly predispose to leakage. Instead, they have suggested that lateral duodenostomy, where the tube is placed through the healthy non-inflamed tissue, may be more effective [43, 44, 47]. In the study by Prigouris and Michas [19], it became apparent that duodenostomy does not lead to a significant decrease in intraduodenal pressure. An alternative decompression can be accomplished by placing the nasogastric tube across the gastrojejunostomy and into the afferent limb in the region of the third portion of the duodenum [48]. End duodenostomy is an effort to create a controlled duodenal fistula. This is employed when technical factors prevent adequate surgical closure of the duodenal stump. Articles regarding closure of the defect in the duodenum over a tube for management of perforated duodenal ulcer or diverticulum, with gastroduodenal continuity, have also been published [48, 49]. Duodenojejunostomy, which is performed for duodenal diverticula perforation, requires a stump closure and does not eliminate the risk of a stump leak. Therefore this procedure is not indicated in problematic duodenal stumps like the ones in our series [50, 51].

There are controversies about removal of TD between postoperative day 10 and 21 [13, 19, 20, 38, 43]. We emphasize three important points regarding removal of the TD. First, amylase concentrations and outputs in Jackson-Pratt drains should not fullfill duodenal leak criteria [37]. Second, there should be enough time for maturation of the Pezzer drain tract; otherwise, drainage of a small amount duodenal content, that ceases within a few days after removal, may cause intra-abdominal spillage leading to peritonitis. Finally, no leak should be seen in the imaging studies obtained through the TD. It is our experience that the TD should remain in place at least 21 days. We noticed only one patient with intra-abdominal fluid collection after removal of the TD on postoperative day 20. Although the patient had fulfilled our removal criteria, he had primary gastric carcinoma. This suggests that in patients whose postoperative course is associated with major complications or malignancy, removal of the TD may be delayed behind postoperative day 21.

Previously, T-tube drainage of the common bile duct, as an adjunct procedure to the TD was not recommended. The main reasons for draining the common bile duct with a T-tube are to decrease the output of the TD by draining out the bile; to gain time for relaxation of partial obstruction from edema in the distal common bile duct caused by the sutures placed around the tube in the seromuscular layer of the duodenum. There was an inverse proportion between outputs of the TD and T-tube during the first 20 postoperative days. Furthermore, leakage from the duodenal stump may cease spontaneously when the output of the leak is low. One patient with a duodenal leak in our series had a T-tube in the common bile duct and the leak ceased spontaneously.

We used a 22 F Pezzer drain in all patients for TD. Larger drains may cause persistent duodenal leakage after removal of the drain. Thinner drains can not be tightened up with pursestring sutures because of an inflamed and edematous duodenal wall, and a duodenal leak around the Pezzer drain may occur. Also, thinner drains may not be adequate to drain the duodenal contents. Although some authors have suggested [6, 42, 46] use of a Foley catheter for TD, we do not find it suitable. A Foley catheter may come out easily and inadvertently; in addition, its balloon may both erode the duodenal mucosa and prevent drainage of the duodenal contents [6].

More recent developments in the management of the difficult duodenum have come from trauma surgeons managing blunt or penetrating duodenal injuries [29, 30]. The use of tube decompression primarily in the management of duodenal wounds is extremely controversial [29, 30]. Although there is little chronic scarring in the patients with gunshot wounds, the presence of significant tissue destruction or devascularization can predispose to duodenal leak after the primary operation. All three of our trauma patients were referred to our center from other hospitals after primary or secondary operations. We performed TD in these patients because of leak complications after the earlier operations.

Resective surgery, including total and subtotal gastrectomy, should be undertaken whenever possible in patients with incurable gastric cancer because both short-term and long-term survival advantages have been demonstrated [24–26]. We observed favorable outcomes for obstruction and pain in four patients with palliative resections. Gastric cancer with duodenal invasion has been reported with an incidence of 15%–40% [27, 28, 52, 53]. These cases are reported to have a poor prognosis, and it is difficult to decide which operative procedure is the best. The first portion of the duodenum measures 4–5 cm, which is sufficient to allow resection of 3–4 cm of the duodenum beyond the pylorus with a safe closure of the duodenal stump. When the lesion extends 3 cm beyond the pyloric ring, pancreaticoduodenectomy has been suggested for curative resection [27]. But this procedure is associated with high morbidity and mortality. Histopathological existence of the microinvasion of the carcinoma in the distal resection

margin of the duodenum after gastric resection, if a frozen-section study is not performed peroperatively, is one of the worst events that a surgeon can encounter a few days after operation. If the gastric resection was performed with curative intent, resection of the duodenal stump with the carcinoma invasion becomes inevitable.

Pancreaticoduodenectomy may be an option in this condition. In two of our cases (T_3, N_2, M_0), duodenal microinvasion was in serosal fatty tissue and it was not possible to detect it macroscopically during the operation. Prognosis is prolonged by curative pancreaticoduodenectomy in gastric carcinomas with long duodenal invasion, pancreatic infiltration, and nodal metastatic lesions around the pancreatic head. Even in such conditions 5-year survival is 37.3% after curative pancreaticoduodenectomy and 33.8% after curative gastrectomy [27]. In the reoperations we performed with pancreaticoduodenectomy in mind, the duodenal stump was resected longer than usual, and TD became inevitable. Intraoperative frozen section analysis showed no tumor existence in any layer of the stump.

The present study demonstrates that TD could be achieved with minimal operative morbidity (12.9 %) and acceptable mortality (6.4 %). We want to emphasize that there is not any series in the literature that included such complicated patients those reported here. Indications for the TD in the light of this study can be listed as (1) insecure duodenal stump closure during gastric resection performed for complicated duodenal ulcer (bleeding, obstruction, and perforation), (2) gastric cancer with duodenal microinvasion; (3) existence of carcinoma in the distal resection margin of the duodenum postoperatively; (4) duodenal leakage caused by duodenal stump leakage after gastric resection performed for any cause, duodenal leakage after primary repair for perforated duodenal ulcer or duodenal trauma, and duodenal leakage after choledochoduodenostomy performed for any causes.

Conclusions

After performing a TD in 31 patients, we conclude that it is a simple, effective, and safe method to prevent rupture of an insecure duodenal stump or to treat leakage from a duodenal stump or primary repair on the duodenum. Tube duodenostomy itself has proved to be a life-saving addition to various surgical procedures in the cases in this study, and frequently an association with T-tube drainage of the common bile duct is advocated.

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