1 **Title page**

2 **Duodenostomy on Foley and gastroenteroanastomosis: treatment of second duodenal part**

3 **perforation.**

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5 **Short Title** Duodenostomy to treat duodenal perforation

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7 **Keywords**: Duodenostomy; duodenal perforation; emergency surgery.

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9 **Date:** April, 1, 2022

Abstract

Background: Duodenal perforation is actually a rare but still life-threatening condition. Ideal approaches for the management of duodenal perforations, are nowadays not so clear and numerous variables, must be considered. Currently, two types of duodenal perforations can be considered according to the presence or absence of a free leakage: Contained and Non Contained Perforations.

Main

In this study we focused on duodenal perforations, requiring a tube duodenostomy and we have analyzed the main features, that have influenced the surgical choices. Five patients were enrolled. Most of duodenal perforations can successfully be managed by simple repair, while complicated procedures are needed for complex injuries. Tube duodenostomy is a damage control procedure, for large duodenal perforations when further repair techniques are not recommended due to the duodenal damage, hemodynamic instability of the patient or the absence of surgical expertise for complex reconstruction.

Conclusions

The tube duodenostomy is an old and dated procedure but simple to implement, which may require an increase in post-operative hospitalization but which, despite everything, remains an effective and safe way to treat patients in critical conditions.

Background

Thanks to introduction of an effective medical therapy (Proton Pump Inhibitors and antibiotics to Helicobacter pylori eradication) duodenal perforation is actually a rare but still life-threatening condition. [i] The reported mortality rate range, is between 8% and 25%.[ii] [iii]

Anatomically, the duodenum consists of four segments: 1. the duodenal bulb, 2. the second part, or descending segment which surrounds the pancreas head, 3. the third segment, is the horizontal part 4. the last segment that follows the jejunum.

When a duodenal perforation occurs, it is most commonly located in the first part of the duodenum, with perforations in the second and in the other parts being much less frequently involved.[i]

Peptic ulcer disease (PUD) is the most common cause of duodenal perforation.[iv] However, autoimmune conditions (scleroderma[v], Crohn disease[vi]), duodenal ischemia, chemotherapy, foreign body ingestion and tumors represent other possible causes[vii] [viii]. Iatrogenic origins, are becoming more commons, because of the widespread use of endoscopic procedures, especially in therapeutic processes as ERCP (Stapfer classification)[ix] [x] [xi].

The ideal approaches for the management of duodenal perforations, are nowadays not so clear. A lot of variables, must be considered, such as the type of perforation, cause, diameter, clinical conditions of patients, availability of Operative Endoscopic Unit, and the involved duodenal segment.

Currently, two types of duodenal perforations can be considered according to the presence or absence of a free leakage: Contained and Non Contained Perforations[viii].

In *Contained Perforations*, (in which free leakage is avoided by contiguous structures, and gastroduodenal juice doesn't produce a diffuse peritoneal irritation) a conservative management is

feasible, in order to avoid surgical procedures[xii]. Conservative management consists of nil per os (NPO), intravenous fluid therapy, intravenous proton pump inhibitors (PPIs), broad-spectrum antibiotics, and eventually H. pylori eradication [viii xiii].

In *Non Contained Perforations*, bowel contents leak into the abdominal cavity, and an operative management is required. In duodenal perforations in which the leakage has been shown to be minimal (*Minor Non Contained Perforations*), the endoscopic approach can be contemplated (through-the-scope clips (TTSC), over-the-scope clips (OTSC), detachable snare loops with clips, and self-expandable metal stents (SEMS)) [viii]. Alternatively simple surgical repair is another choice with or without omental coverage[xiv].

In *major non contained perforation,* a reconstructive surgery is mandatory.

Despite all, medical therapy, early diagnosis, endoscopy, new surgical evidences there are still some cases in emergency that require a duodenostomy. The aim of our study is to elucidate which are these factors requiring the duodenostomy and which postoperative course is for these patients.

Methods

From September 2018 to December 2019, about 30 patients with symptomatic duodenal ulcer were studied, at our Division of General Surgery, treated by medical therapy, endoscopic techniques, o surgical approaches (a combined, laparoendoscopic approach was, in specifics scenarios, performed). In 2 cases a tube duodenostomy was executed, due to excessive size of perforation and extreme presence of intra-abdominal infections.

In addition, other cases of duodenal injury due to other causes were treated, 3 of these requiring a tube duodenostomy approach.

In this study we focused on duodenal perforations, requiring a tube duodenostomy and we have analyzed the main features, that have influenced the surgical choices. In all patients, bowel perforation was diagnosed using a ordinary set of blood and radiologic investigations confirming the evidence of pneumoperitoneum. We have enrolled 5 patients.

Surgical and clinical details.

All described cases were performed with an open laparotomy approach. Inside the abdominal cavity there was abundant yellowish purulent material, and after lavage of entire peritoneal cavity, the first phase was the Kocherisation of the duodenum in order to allow a better manipulation and decrease any tension to repair site. The next step is to clean the edges of the perforation. Excision with scissors of 2-3 mm of the margin would, growths the diameter of the injury.

The repair of the duodenal perforation using 2/0 polyglactin (Vicryl; Ethicon, Somerville, NJ, USA) sutures is now performed.

The next step is the Pyloric exclusion followed by Duodenotomy upstream of the lesion with the introduction of a large diameter Foley catheter bringing this out as a duodenostomy.

Finally follows, the formation of a transmesocolic gastrojejunal anastomosis on omega loop and downstream entero-entero anastomosis, abdominal drainages near the duodenum and gastrointestinal anastomosis.

All tubes are initially kept unclamped to drain abdominal liquids, end duodenal materials by the duodenostomy. On 5^{th} 7^{th} PODs, the patients resumed eating and the day after the drain close to gastrointestinal anastomosis is removed. After 6^{th} – 9^{th} PODs the duodenostomy is clamped, and an evaluation of the drain near to duodenum is made. If the volume of the drainage is small the drain can be removed, the duodenostomy is slightly mobilized and superficialized and the patient discharged. The duodenostomy tube can be removed at 4 weeks after surgery during a check up visit.

Results

Five patients underwent tube duodenostomy due to duodenal perforation were analyzed and their data collected (Table 1).

Table 1 Clinical preoperative details. (GDU Giant Duodenal Ulcer, PUD Peptic ulcer disease, Type 1 refers to Stapfer Classification)

In cases of GDU (Giant Duodenal Ulcer) for PUD (Peptic ulcer disease) , the excessive size of the perforation associated with a septic involvement of the operative field, due to a peritonitis that in one of the cases lasted for more than 48 hours, meant that the operative choice leaned towards a duodenostomy. Furthermore, although not common, but in both cases the ulcer site was located on the second part of the duodenum. The case of intraoperative duodenal damage occurred during a drainage operation of the retroperitoneal loggia and right nephrectomy, because of rupture of a voluminous complex cyst, performed by the team of Urologists. The lesion involved the lateral wall of the second duodenal portion, and the presence of abundant purulent material contraindicated primary repair, so a duodenostomy was performed.

Perforations that occurred during endoscopic preocedures involve biliary stenting in the case of unresectable biliary tract cancer, and perforation of duodenal diverticulum in a very elderly patient with obstructive jaundice due to choledocholithiasis. In the first case, the adhesions due to the neoplastic mass did not allow an optimal and safe approach of the edges of the perforation. In the second case the advanced age of the patient, and the onset of hemodynamic instability also due to the patient's comorbidities, made reparative techniques impossible. In both of these latter cases the perforation was sutured around a Foley catheter introduced into the perforation to develop directed fistulation of the perforation.

All patients suffered postsurgical complications ranging from wound infection to pneumonitis, but the incidence of severe complications was greater in the older patients (table 2).

Table 2 Postoperative outcomes and complications. (POD Post-operative days)

Thanks to the gastrojejunal anastomosis, patients can resume feeding quite early. Recovery occurs initially only with liquid food. Clamping of the duodenostomy is done a day or two after resumption of feeding, and the day after periduodenal drain is removed. The complications observed had a proportional impact on the duration of hospitalization, as patients had to complete courses of antibiotics, for exclusive hospital use, to battle the condition of sepsis. One day before discharge, the duodenostomy tube is mobilized and superficialized. The duodenostomy is removed 4 weeks after surgery. We have not recorded any deaths 4 months after the operation.

Discussion

Duodenal perforation remains a surgical emergency. Features as old age, comorbid situations, shock, sepsis, large size of perforation, and delay in treatment have been identified as adverse factors in the managing of this disorder[xv]

Most of duodenal perforations can successfully be managed by simple repair, while complicated procedures are needed for complex injuries or large perforations of the duodenum due to peptic ulcer disease[xvi].

Tube duodenostomy is a damage control procedure, for large duodenal perforations when further repair techniques are not recommended due to the duodenal damage, hemodynamic instability of the patient or the absence of surgical expertise for complex reconstruction [xvii]. In fact, tube duodenostomy is easy to learn, teach, and perform.

The role of tube decompression of the duodenum was already proven in 1950s, but this technique is still used, as shown in several recent studies.

In 2006 van Ginhoven et al, analyzed Three cases in which the injury of the duodenum could not be repaired tension-free. Therefore, a Foley balloon catheter was used to close the rupture and After a few weeks, patients were fed through the Foley catheter duodenostomy until a fistular track was formed. On removal of the catheter the fistular track closed spontaneously including the perforation of the duodenum.[xviii]

Even in the case of blunt abdominal trauma, which involves Combined gastric and duodenal perforation, Singh et al, suggest a Primary repair of duodenal transaction over Malecot catheter (tube duodenostomy). [xix]

Nobori C et al, performed a Gastric disconnection, comprising antrectomy including resection of the ulcerated portion, tube duodenostomy, and tube gastrostomy due to a giant duodenal ulcers after neurosurgery for brainstem tumors that required reoperation for gastric disconnection.[xx]

Dubecz et al, made a review about management of ERCP-related small bowel perforations, and duodenostomy is proposed in case of duodenal perforation in duodenum difficult to manage,[xxi] while Bharathi suggest a tube duodenostomy as a safe procedure to manage an intra-peritoneal duodenal perforation caused by delayed migration of endobiliary stent.[xxii]

Hatzigeorgiadis et al., suggest a tube pancreatico-duodenostomy for management of a severe penetrating pancreaticoduodenal injury as an option in pancreaticoduodenal trauma when the inner medial duodenal wall cannot be repaired[xxiii].

Duodenostomy is still a good procedure, especially in extreme circumstances, in the presence of giant ulcers with severe tissue inflammation, or in very extensive injuries in life threatening situations.

We believe that the success of this method depends on some key steps in the procedure, as the Kocherization of the duodenum, which assurances a tension-free repair, good vascularization of the injury site and big size duodenostomy to be placed downstream of the second part of the duodenum. The critical point is keeping the duodenum empty and without tension by decompressing all fluids enter or are secreted into the region. The pyloric exclusion and the realization of a gastro-jejunum anastomosis, is not always performed by the surgeons, but allow an early resumption of feeding, as the duodenum is excluded from food transit.

Conclusions

Tube duodenostomy is a damage control procedure, for large duodenal perforations when further repair techniques are not recommended. The tube duodenostomy is an old and dated procedure but simple to implement, which may require an increase in post-operative hospitalization but which, despite everything, remains an effective and safe way to treat patients in critical conditions.

184 *Table 3 Clinical preoperative details. (GDU Giant Duodenal Ulcer, PUD Peptic ulcer disease, Type 1*
185 *refers to Stapfer Classification)*

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DUODENAL INJURY	UNDERLYING PATHOLOGY	SEX	AGE (Y)	DURATION OF PERITONITIS (H)	SEPTICEMIA	HEMODYNAMIC INSTABILITY (SHOCK CLASS)
GDU	PUD	F	46	<48	Yes	No
GDU	PUD	M	71	>48	Yes	Yes (Class I)
OPERATIVE INJURY	Surgical retroperitoneal drainage	M	45	<48	No	No
ENDOSCOPIC PERFORATIONS (TYPE 1)	Malignant jaundice in Bile Duct Cancer	F	73	<48	No	No
ENDOSCOPIC PERFORATIONS (TYPE 1)	Duodenal diverticulum in Choledocholithiasis	M	89	>48	No	Yes (Class II)

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188 *Table 4 Postoperative outcomes and complications. (POD Post-operative days)*

DUODENAL INJURY	RESUMPTION OF FEEDING (days)	CLAMPING DUODENOSTOMY (days)	WOUND INFECTION	PNEUMONITIS	HOSPITAL STAY (days)	DEATH
GDU	5 POD	6 POD	Yes	No	10	No
GDU	7 POD	9 POD	Yes	Yes	16	No
OPERATIVE INJURY	5 POD	7 POD	No	No	22	No
ENDOSCOPIC PERFORATIONS (TYPE 1)	6 POD	8 POD	Yes	Yes	18	No
ENDOSCOPIC PERFORATIONS (TYPE 1)	6 POD	8 POD	No	Yes	18	No

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Conflict of Interest

The authors have no conflicts of interest to declare.

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Data Availability

All data generated or analyzed during this study are included in this article. Further enquiries can be directed to the corresponding author.

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