International Journal of Research in Medical Sciences
Ferrer MPT et al. Int J Res Med Sci. 2024 Sep;12(9):3482-3490
www.msjonline.org
pISSN 2320-6071 | eISSN 2320-6012

DOI: https://dx.doi.org/10.18203/2320-6012.ijrms20242637

Review Article

Duodenal's perforation, a surgeon's challenge

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Received: 02 July 2024
Revised: 19 August 2024
Accepted: 20 August 2024

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ABSTRACT

Duodenal perforation (DP) represents a rare but potentially fatal condition. Delayed diagnosis and failure to provide appropriate management lead to devastating outcomes. It is known that timely treatment (<24 hours) of duodenal perforations reduces morbidity and mortality. Currently, there are multiple surgical options for managing DP, each with its respective potential complications; however, there is no consensus or national or international guidelines validating the best surgical method for treatment. This review article aims to provide the available surgical options with the lowest morbidity rates to address such a complex pathology.

Keywords: Duodenum, Intestinal perforation, Duodenum surgery, Duodenal injury, Duodenal diseases

INTRODUCTION

Duodenal perforation (DP) represents a rare but potentially fatal condition. The management of duodenal perforations remains controversial, with no current consensus among experts on the optimal treatment. Traditionally, surgery is considered the most appropriate treatment approach. Currently, there are less invasive treatment options, such as endoscopic approaches, which generally yield controversial conclusions. Data from the literature on surgical management outcomes are scarce, and the surgical approach tends to depend directly on the surgeon's preference and experience. Therefore, recommendations are lacking on the optimal timing of repair and/or the appropriate type of reconstruction. This review of the topic will provide surgeons with the necessary tools to choose the best surgical option for treating DP and avoid important complications. The last 20 years of the past century witnessed a major shift for peptic ulcer disease (PUD) by recognizing the role that Helicobacter pylori (HP) infection plays in producing the acid hypersecretion characteristic of peptic ulcers. Attempts to control this acid hypersecretion led to a surgical revolution during the 1950s and 1960s. Thanks to the advent and easy access to acid antisecretory drugs (proton pump inhibitors and histamine type two receptor blockers), the incidence of complications related to acid-peptic disease has been reduced, resulting in a decrease in surgical management. However, surgical treatment of ulcer perforation remains an important basic element of surgical practice.

Understanding surgical management is crucial as surgery is the cornerstone for the emergency treatment of life-threatening PUD complications. In addition to secondary duodenal perforation due to PUD, there are various causes, including iatrogenic origin, which is important to mention due to the increased risk of duodenal injury and perforation with the rise of minimally invasive procedures like endoscopy, endoscopic retrograde cholangiopancreatography (ERCP), laparoscopy (urology, colorectal surgery, and general surgery). The ideal approach to managing duodenal perforations is not clear and must consider multiple variables such as the type of perforation, cause, diameter, clinical condition of

the patient, availability of an endoscopic unit, experienced surgeon, and the involved duodenal segment.

EPIDEMIOLOGY

DP is a rare but potentially fatal injury. Among the etiologies associated with duodenal perforations are PUD (the main cause), iatrogenic causes, and trauma.[1,2] Duodenal ulcers, a manifestation of PUD, represent two-thirds of all ulcers.[3]

It is a common surgical emergency that every surgeon should be knowledgeable about managing. Acute perforation in patients with duodenal ulcer is estimated to occur in 2-10%.[2,3] Up to 81% of patients with perforated duodenal ulcers are shown to be positive for *H. pylori* infection.[3] The lifetime risk in untreated PUD patients of developing gastroduodenal perforation is on average 10% (11-14% in men and 8-11% in women), and 30-50% of perforations are associated with nonsteroidal anti-inflammatory drug (NSAID) use.[3,4]

More than 95% occur in the first part of the duodenum, and usually duodenal ulcers are benign. The most common site of perforation is the anterior wall (92%), and 10% of these are associated with a concurrent hemorrhagic ulcer on the posterior wall (kissing ulcer).[3] Iatrogenic duodenal injuries, leading to free perforation into the peritoneal cavity or a contained abscess within the retroperitoneum, represent a rare but highly morbid condition with mortality rates up to 25%.[2]

DUODENAL PERFORATION SECONDARY TO ENDOSCOPIC RETROGRADE CHOLANGIO-PANCREATOGRAPHY AND ITS TREATMENT

Iatrogenic injuries in this specific area of the gastrointestinal tract (duodenum) occur as a consequence of endoscopy. Regarding endoscopic injuries, the relative risk increases substantially when invasive endoscopic maneuvers are employed, such as endoscopic retrograde cholangiopancreatography (ERCP), generally complemented with sphincterotomy, when attempting to control a bleeding site in the duodenal mucosa, or during a polypectomy.[5]

Around 10% of patients undergoing ERCP develop complications such as pancreatitis, bleeding, or perforation. The incidence of duodenal perforation related to ERCP is between 0.09% and 1.67%, with a mortality rate of 8%.[2] The risk factors for duodenal perforation includes the following.[5,7,8]

Patient factors

Suspected sphincter of Oddi dysfunction, female gender, advanced age, normal bilirubin levels, abnormal or distorted anatomy such as situs inversus or Billroth II reconstruction after gastrectomy.

Procedure factors

Difficult cannulation, contrast injection into the pancreatic duct, sphincterotomy, precut technique, balloon sphincter dilation, and low endoscopist experience. Traditionally, surgical management was considered appropriate; however, in the last decade, a more selective approach with both endoscopic and conservative options has evolved. The European society of gastrointestinal endoscopy recommends endoscopic management for perforations less than 12 hours old. endoscopic modalities include the following.[9]

Through-the-scope clips (TTSC)

For small and linear perforations (less than 1 cm).[2,9]

Over-the-scope clips (OTSC)

For perforations between 1 to 3 cm.[2,9,10]

In 2000, Stapfer et al described a useful classification of duodenal perforations secondary to ERCP, which remains relevant today, guiding their management based on the mechanism, anatomical location, and severity of the injury. They classified the perforations into four types (Figure 1).[7] Lateral or medial duodenal wall perforation, Indication for emergency surgery. The magnitude of the surgical procedure is proportional to the degree of injury.[11] The American gastroenterological association (AGA) recommends early endoscopic management for perforations smaller than 3 cm with TTSC, OTSC, band ligation, or endo loops, achieving a success rate of 88-100% for perforations less than 13 mm.[9]

Peri ampullary (43%), medical management they usually tend to seal spontaneously in 62%, corroborated by imaging (intestinal transit and/or CT with water-soluble contrast) initial and serial at 8 and 48 hours to confirm that there is no leak and excludes the presence of collections.[7] The AGA recommends placing metal stent auto expandable in the common bile duct and that it crosses the shaft favoring closure.[9]

Indication of surgical treatment is the presence of a large collection, retained stones or instruments. Distal common bile duct injury related to instrumentation by guides or baskets. They are small. Their treatment is the same as type II.[7,8] Retroperitoneal air, related to the use of compressed air to keep the lumen open. It is not a true perforation so it does not require surgical intervention.

DUODENAL PERFORATION SECONDARY TO SURGICAL PROCEDURES

In addition to endoscopic lesions, surgical procedures performed near the duodenum make the duodenum susceptible to involuntary injury, an example of this is secondary to urological procedures such as right nephrectomies, since being two organs in close contact, a

non-meticulous dissection of the renal capsule can generate a duodenal injury.[11] In 2017, the database of 330 patients operated on with retroperitoneal laparoscopic radical nephrectomy was analyzed in order to report complications associated with said procedure. There were 73 complications in 63 patients (19.1%), of all the complications, duodenal perforation only occurred in one case, the reason for which surgery was performed.[12]

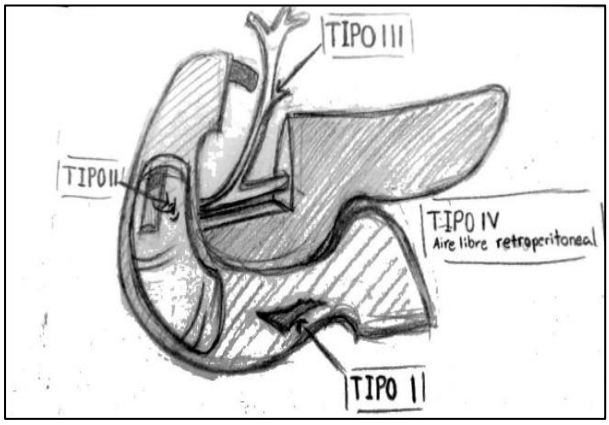

Figure 1: Stapfer's classification.

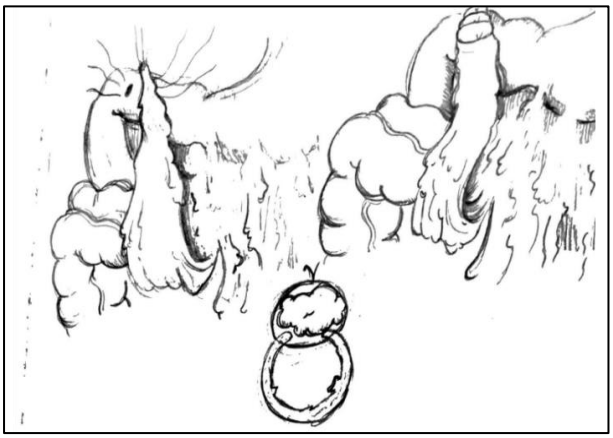

Figure 2: Cellian-Jones technique.

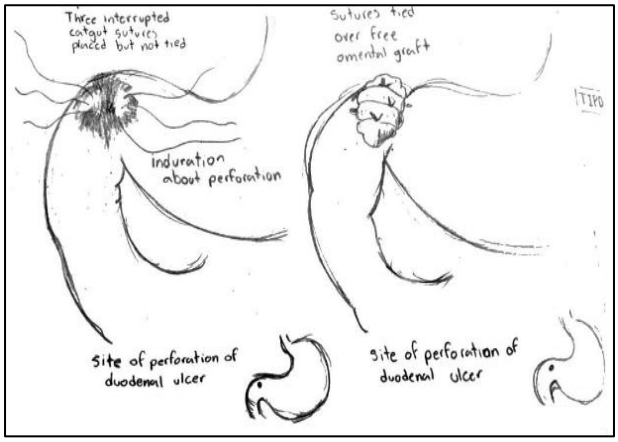

Figure 3: Graham's patch.

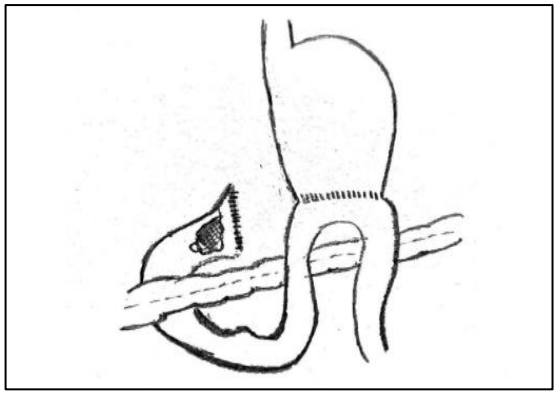

Figure 4: Van Eiselsberg technique.

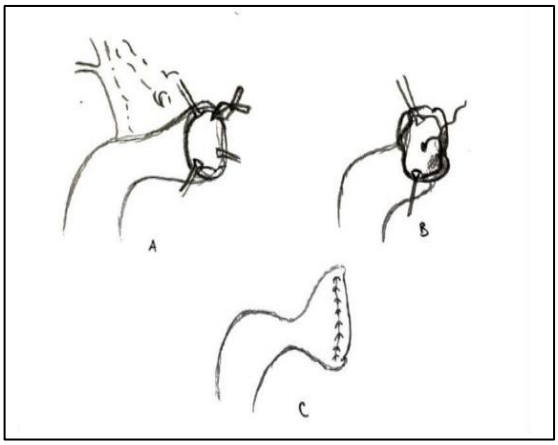

Figure 5: Finsterer-Bancroft-Plenk technique: A) the antrum has been sectioned to 4-5 cm from pylorus, preserving the irrigation of the pylorus. The mucosa is dried following the submucosal plane; B) the mucosa has been dried up to the hole of the pylorus, which is closed with jareta & C) operation completed.

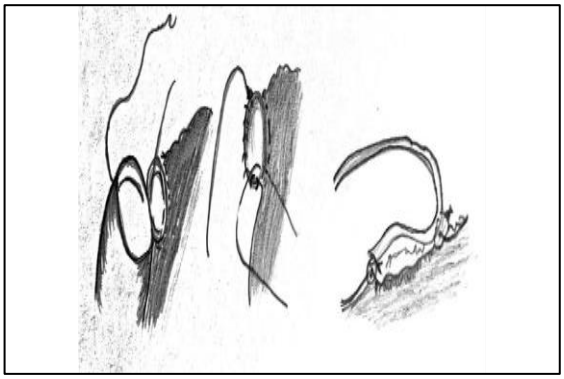

Figure 6: Bsteh-Nissen's technique.

To make the foreground the inner edge of the duodenum is continued with the callosa edge of the penetrating ulcer in pancreas. The second plane again faces the callosa edge of the ulcer with the anterior face of the duodenum. This way the anterior face covers the ulcer and has contributed to closing the duodenum.

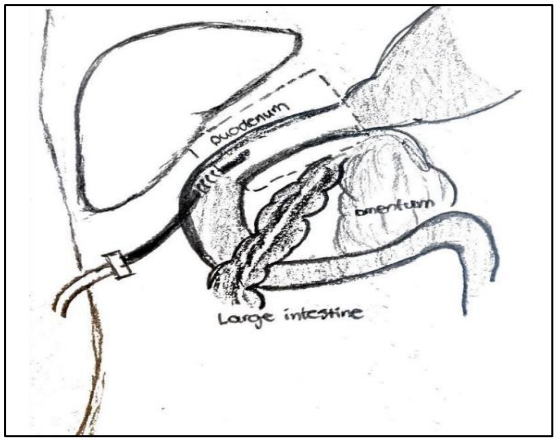

Figure 7: Duodenostomy technique secured with Witzel technique.

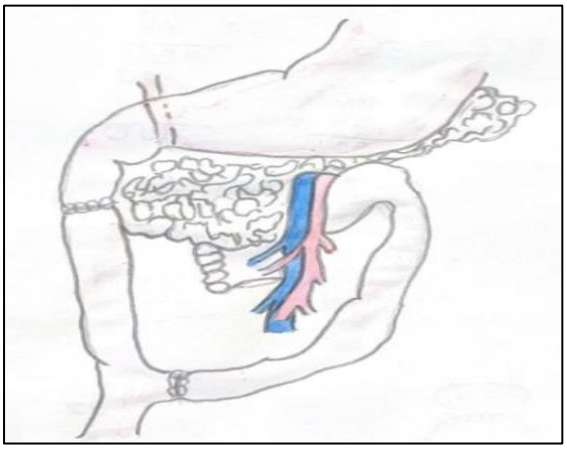

Figure 8: Duodenal anastomosis technique in Y of Roux.

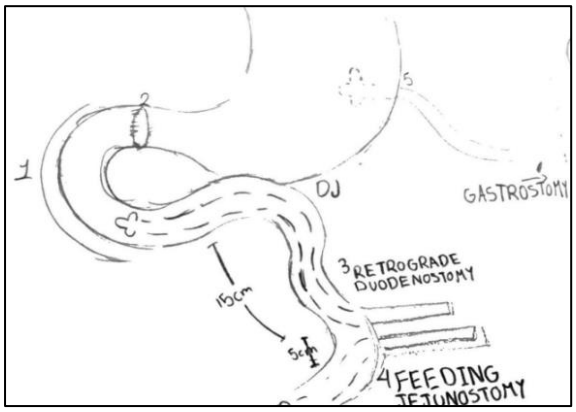

Figure 9: Triple stoma technique-controlled tube duodenostomy in the management of giant duodenal ulcer perforation: a new technique for a surgically challenging condition.

MEDICAL MANAGEMENT

Nowadays multiple studies support satisfactory medical management. Patients who are candidates for non-surgical management are those who are hemodynamically stable, with localized abdominal pain, absence of signs of peritonitis and water-soluble contrast imaging with evidence of contained perforation. Treatment is based on levin tube decompression, intravenous hydro electrolytic resuscitation, proton pump inhibitor, broad-spectrum antibiotic therapy, serial physical examination (preferably by the same doctor), follow-up endoscopy and treatment to eradicate *H. pylori*. Indications for discontinuing medical treatment in favor of surgical management include no improvement in 12-24 hours, signs of peritoneal irritation and hemodynamic instability.[3]

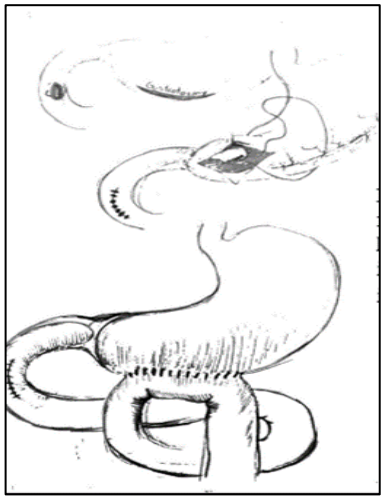

Figure 10: Vaughan-Jordan procedure.
It is used for the treatment of combined duodenum and head lesions of the pancreas, as well as in isolated duodenal lesions where duodenal repair is suboptimal.

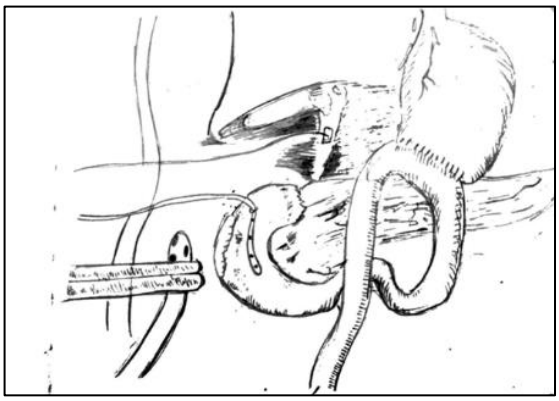

Figure 11: Berne´s procedure. Duodenal "diverticulization" for duodenal and pancreatic injury.

PERFORATION LESS THAN 2 CM

Management is still controversial with the lack of consensus among experts regarding optimal treatment. The principle of surgical management is to achieve rapid access to the abdominal cavity, perform Kocher maneuver for mobilization of the duodenum and identify

the site and nature of the perforation, as well as an immediate aspiration of all the gastrointestinal fluid spilled into the peritoneal cavity.

If the patient is stable and has a history of EPU, complications related to EPU and/or history of eradication of H. pylori should be included a definitive surgery for the ulcer, highly selective vagotomy is preferred, as it has fewer adverse effects. If the patient has no history of EPU, has multiple comorbidities, is hemodynamically unstable, perforation is long-term (>24 hours) and/or peritoneal contamination is abundant, definitive procedures for ulcer should be omitted.[3]

Perforations of less than 2 cm involve simple and rapid surgical management, resulting in reduced surgical procedure time, a decrease in exposure to anesthetic effects and be transferred to intensive care for stabilization and post-surgical follow-up. Four commonly used techniques are mentioned below.[4]

Cellian-Jones technique (1929)

It is an omentoplasty without primary closure of the defect to prevent duodenal narrowing. It consists of placing a pedicle omentum plug at the perforation site by attaching it with 4-6 stitches (Figure 2).

Omentum patch (omentopexia with Graham patch introduced in 1937)

It consists of placing an omentum plug (free, not pediculated) in the defect and securing it with suture (Figure 3).

Primary closure

Consists of approximating the edges of the defect with absorbable suture.[4] Graham patch modified. It approximates the edges of the defect with continuous suture (usually absorbable) and with the same suture material part of the omentum (pediculate) is secured on top to provide extra support. Because most duodenal ulcers are secondary to *H. pylori* infection, patients are candidates for antibiotic therapy to eradicate *H. pylori*.[13]

There are discrepancies between primary closure versus the use of omentum. A systematic review with meta-analysis compared primary closure versus OPG 14. The main result to compare was postoperative bile leakage secondary to repair dehiscence between the technique with primary closure versus OPG (OR 0.64, 95% (0.26-1.54) and 0.66, 95% (0.25-1.76)) respectively. The operating time was lower in the primary closure group by 5.6 min, 95% CI (-21+10.4), p=0.0002. It was concluded that there is no statistically significant difference in clinical outcomes (postoperative biliary leakage, surgical site infection, oral initiation time) or mortality, both of which are safe in the emergency surgical repair of a perforated small peptic ulcer. The world emergency surgery society (WSES) recommends primary closure for perforations under 2 cm.[16]

The use of drains in the previously described techniques remains optional for the surgeon. Drains are useful in case of inadequate peritoneal lavage or residual sepsis. In addition, use of drains increases the risk of drainage site infection by 10% and drainage by itself can cause intestinal obstruction. Drainage will not reduce the incidence of intraabdominal collections or abscesses.[17]

LAPAROSCOPIC MANAGEMENT OF PERFORATED DUODENAL ULCER

Currently in clinically stable patients laparoscopic repair is recommended, in addition to theoretically laparoscopic access is associated with fewer metabolic and physiological alterations as opposed to access in open surgery, which benefits septic patients. It has been reported that primary closure can be performed by laparoscopic approach.

In 2023, a systematic review with meta-analysis compared the management with omentum patch versus primary closure of laparoscopic perforated ulcer with a total of 438 patients, concluded that there is no statistically significant difference in postoperative ileus (OR 0.76, p=0.61), leakage (OR 1.17, p=0.80), wound infection (OR 1.89, p=0.34), intraabdominal abscesses (OR 1.17, p=0.87), reintervention (OR 0.00, p=0.94) and mortality (OR 0.55, p=0.48), the difference is that the operating time was significantly less in the primary closure group (p=0.02).[13] The laparoscopic approach to PD repair has been established as safe and effective. Contraindications for laparoscopic management of perforated duodenal ulcer are large perforations, posterior location, hemodynamic instability.[3]

GIANT PERFORATION.

Just as the time of evolution is proportional to morbidity and mortality, so is the diameter of the perforation due to extensive inflammation and loss of duodenal tissue. Perforations of 2 cm or more represent 1-2% of perforated peptic ulcers and 5% of peptic ulcers that merit surgical management. They also lead to a morbidity of 20-70% and a mortality of 15-40%.[3,22] Because of the above they are called complex perforation or giant3. The male-female relationship is 3:1. It is currently known that the etiology of giant duodenal ulcers is mainly related to the chronic use of NSAIDs.

Closing or repairing complex perforations is a challenge, because primary closure of a large defect (greater than 2 cm) involves safely suturing viable tissue, ensure a closure with the least possible tension and reinforce the repair with vascularized tissue such as the omentum to provide a waterproof barrier. The open approach allows the extensive kocher maneuver to mobilize the duodenum and ensure a tension-free closure. A well-made open

closure is preferred to a suitable but marginal laparoscopic closure. A prospective randomized study of 100 patients compared surgical management with omentum plug versus omentopexia in perforated giant duodenal ulcer, concluded that the omentum patch is a safe and cost-effective method.[23] The WSES recommends for perforated ulcers of more than 2 cm a customized approach taking into account its location.[16] The above according to the premise "less is better".

Despite having scientific evidence regarding the success in the management of giant duodenal perforations with simple procedures such as the omentum patch or primary closure, not in all patients is resolutive presenting closure dehiscence, leakage, duodenal light stenosis, friable tissue tear. The following surgical options are recommended.

Billroth I technique

Choice in non-malignant pathology of the stomach or duodenal ulcers requiring gastrectomy. Avoid problems of the duodenal stump.

Van Eiselsberg technique

Consists in avoiding the treatment or resection of the distal gastric pathology (including proximal duodenum) by closing the stomach proximal to the lesion and then performing a gastro jejunal anastomosis (Figure 4). It was indicated in stenosis ulcer processes. It is not currently recommended as it is known that leaving the anthill increases gastrin production by stimulating hydrochloric acid production and ulcerogenic activity.

Finsterer-Bancroft-Plenk technique

Indicated in giant perforated duodenal ulcer with abundant perilesional edema, deformed, retracted or friable duodenum that does not allow proper dissection of the pylorus but above all the presence of perforation involving duodenal posterior face on the head of the pancreas or high risk of injuring the bile duct at the time of dissection in an attempt to perform a standard procedure for duodenal closure. It consists of performing a precpyloric exclusion and removal of the antral mucosa.[24] This method was criticized for the possibility of retaining residual antral mucosa which is a determining factor for recurrence of EPU (Figure 5). The intestinal transit is restored with a lateral end Gastrojejunal anastomosis.[13,24]

Bsteh-Nissen technique

Indicated for the management of duodenal ulcers with penetration to the pancreas on condition that the anterior duodenal wall is normal. The technique consists of finely dissecting the posterior duodenum from the two thirds proximal to the perforation, the anterior duodenal wall opens on the same location of the ulcer, dissects and separates from the bed of the ulcer and the distal duodenum in such a way that the open gastric remnant is proximally freed and then anastomosed with a final techni quelateral to a jejunal loop in Y of Roux to restore gastrointestinal transit (Figure 6).[24,26]

Duodenostomy drainage tube

It is a damage control procedure for giant duodenal ulcers when the rest of the surgical techniques are not recommended due to duodenal damage, hemodynamic instability or absence of surgical experience for complete reconstruction.[27] Placement of a drainage tube to the duodenum is appropriate when a good closure of the duodenum cannot be performed or when the closure of the duodenal stump is considered unsatisfactory or unsafe by the condition of the walls. The probe can be placed at the level of the perforation directly or the closure of the perforation can be performed with subsequent duodenostomy prior to the repair. A Foley tube is usually used. Another indication to perform duodenostomy is in order to decompress the duodenum to avoid dehiscence of the duodenal stump, the duodenostomy is placed distal to the stump with Stamm or Witzel technique (Figure 7). In any of the previously described cases the duodenostomy should remain open and its removal is indicated from 10-12 days, some bibliographies recommend the withdrawal at 4 weeks.[27,28]

Duodeno yeyunostomy (DY)

indicated in patients with giant penetrating duodenal ulcer towards the head of the pancreas, and/or localized perforation between vater's papilla and superior mesenteric vessels when tissue loss does not allow a primary closure.[29] The technique involves performing a meticulous dissection of the duodenum and performing duodenal resection at the puncture site. The distal duodenum is prepared leaving the edges of its anterior and posterior face of at least 3 mm to allow a termino-lateral or laterolateral anastomosis. Transit restitution is performed with a gastrojejunal termino-lateral anastomosis with Roux Y reconstruction (Figure 8). To provide additional protection for the DY anastomosis, a T-tube may be placed to derive bile.[40]

Triple ostomy technique

The technique consists of previous Kocher manoeuvre, the perforation is identified, performing closure with modified Graham patch, three ostomies with Foley catheter are performed. A retrograde duodenostomy with 14 Fr catheter on the anti-mesenteric rim 15 cm distal to the Treitz ligament that will function as a controlled fistula. Gastrostomy with catheter 14 Fr that drains the gastric juice and the reflux of bile towards the stomach decreasing the load of secretions towards the duodenum. Feeding jejunostomy with catheter 10 Fr at the anti-mesenteric edge 10 cm distal to the duodenostomy that allows the early onset of the enteral pathway which has a

trophic effect and avoids the need for total parenteral nutrition and its complications (Figure 9).[32]

Vaughan-Jordan procedure (pyloric exclusion with Gastrojejunum anastomosis)

Described in 1977 as a simpler technique of "duodenal diverticulization" which eliminates the need for gastric resection by creating a temporary exclusion of the duodenum from the normal flow of gastric contents.[35] Indicated when classic repair with omentopexia with Graham patch or modified Graham patch have failed, when there is high risk of duodenal leakage, when the degree of inflammation is severe or when the general condition of the patient and/or the quality of tissue are poor.[21] It consists of the primary closure of the duodenal perforation with defunctionalisation of the pylorus to allow a proper healing of the defect.[29] The intestinal transit is restored with a gastrojejunal laterolateral anastomosis using the previously made gastrostomy (Figure 10). It is recommended to use a feeding jejunostomy to ensure an adequate route of nutritional contribution.[36]

"***Duodenal diverticulization", Berne procedure***

Consists in the complete isolation of the duodenal lesion from the physiological fluids of the gastrointestinal tract. Its indication for the concomitant treatment of extensive duodenal and pancreatic injury as well as severe duodenal injury has been in disuse because it is a very invasive and extensive procedure.[29] The essential components of this technique are: primary closure of the duodenal lesion, antrectomy with gastro jejunum lateral terminus anastomosis, duodenostomy probe, T-tube and drainage (Figure 11).[37]

Duodenal perforation from trauma

Traumatic injuries to the duodenum are rare, accounting for less than 2% of abdominal injuries. It should be noted that the majority of these injuries are due to penetration mechanisms (gunshot or puncture injury) and associated with synchronous injury with other organs.[2,39] Like any trauma patient, the priority is hemodynamic stability. If the patient presents evidence of severe physiological involvement in the form of acidosis, hypothermia or coagulopathy, damage control management should be carried out (control of bleeding, simple closure of duodenal, ligation or placement of a T-tube to bypass the bile duct) early, to transfer the patient to intensive care.

In the case of the hemodynamically stable patient a meticulous review must be performed and a definitive treatment may be chosen. The American association of trauma surgeons propose an algorithm for the surgical management of duodenal lesions in hemodynamically stable patients, according to their classification.[38]

CONCLUSION

The management of duodenal perforations remains controversial, without a current consensus on optimal treatment. Surgery is traditionally considered the most appropriate treatment approach. However, less invasive treatment options have recently been tried, such as endoscopic approaches. Recommendations on the optimal timing of the repair or the appropriate type of reconstruction are lacking and management tends to depend directly on the surgeon's preference and experience. Due to the above, this review of the topic is intended to guide the surgeon by providing him with the various current surgical tools for the repair of the duodenal perforation. The ideal approach in the management of duodenal perforations is not clear, multiple variables should be taken into account such as the type of perforation, cause, diameter, clinical condition of the patient, availability of endoscopic unit, experienced surgeon and the duodenal segment involved. Taking into account the principle of no maleficence, which translates into that in this type of pathology, submitting the patient to a longer surgical time with complex procedures results in an increase in their morbidity and mortality so simple and resolutive procedures are preferred: "less is better".

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: Not required

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Cite this article as: Ferrer MPT, Bautista LES, Reyes KS. Duodenal's perforation, a surgeon's challenge. Int J Res Med Sci 2024;12:3482-90.