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A simple intra-operative maneuver to decrease a duodenal ulcer hemorrhage temporarily: description and anatomical bases

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Abstract Intraoperative hemostatic suture to treat a bleeding duodenal ulcer is sometimes difficult when there is massive hemorrhage. The aims of this paper are: (1) to describe a practical and easy intraoperative procedure which quickly decreases a massively bleeding duodenal ulcer, allowing the surgeon to identify the bleeding site clearly and obtain definitive hemostasis by suturing the involved vessels with a low risk of common bile duct lesion; and (2) to study in cadavers the anatomical basis of this surgical procedure already successfully performed on patients. Fourteen patients with massive duodenal ulcer bleeding, after unsuccessful endoscopic hemostasis, were operated on and included in this study. After surgical anterior gastroduodenotomy, the surgeon introduced a finger in a downward and forward direction in the bursa omentalis vestibule through the omental foramen. This simple and quick procedure decreased hemorrhage by compressing the gastroduodenal artery against the first part of the posterior surface of the duodenum. Twenty-four fresh blocks of normal tissue were removed from cadavers and were injected with silicone rubber through the common hepatic artery. The distance between the gastroduodenal artery and the omental foramen was measured. With this maneuver the surgeon can clearly see the exact bleeding site and perform an adequate suture with a minor risk of common bile duct lesion.

Keywords Gastroduodenal artery · Peptic ulcer hemorrhage · Duodenum · Emergencies · Hemostasis · Peptic ulcer surgery

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Introduction

Medical treatment is the main therapeutic option for the majority of patients with duodenal peptic ulcer. Surgical treatment is, however, necessary—today as in the past—when one is confronted with difficult and complicated cases, namely those which include medical intractability, hemorrhage, obstruction and/or perforation [4, 6, 11].

Emergency endoscopy for diagnosis and treatment purposes is the first standard procedure for bleeding ulcers [9, 10, 14]. In a few cases it can be complemented with angiography to assure cessation of the hemorrhage by local infusion of vasopressin, or by embolizing the bleeding vessel [7, 11, 12].

In 5—15% of patients [3] with severe bleeding and hemodynamic instability refractory to endoscopic control a surgical intervention will be required [2]. A bleeding peptic ulcer is often situated on the posterior wall of the first part of the duodenum. The most serious hemorrhages are due to erosion of the gastroduodenal (GD) artery or the posterior superior pancreatoduodenal (PSPD) artery, situated behind the duodenum [13].

The aim of surgical treatment is to stop hemorrhage by direct or indirect procedures and to treat the ulcer. During the surgical intervention, after anterior duodenotomy, the ligation of the bleeding vessel may be difficult if there is massive local hemorrhage. This aggressive bleeding is often initially decreased by direct digital pressure over the arterial bleeding site. Finger

Fig. 1 The index finger was introduced into the omental vestibule through the omental foramen and directed downwards and forwards simultaneously to decrease intraoperative duodenal ulcer hemorrhage (procedure represented in a cadaver). *a*, Pylorus; *b*, right gastric artery

pressure makes needle penetration difficult, however, and increases the probability of a common bile duct lesion [13].

This emergent problem has been widely studied but there has been no report of an easy intraoperative procedure to decrease massive hemorrhage in order to perform a safe arterial ligation.

The aim of this paper is to describe a practical and easy procedure, apparently not described in textbooks of surgery, that quickly decreases a massive duodenal ulcer hemorrhage, allowing the surgeon to clearly identify the bleeding site and to obtain definitive hemostasis by suturing the involved artery, with a low risk of common bile duct lesion.

Materials and methods

Study in patients

Fourteen patients (9 men, 5 women) with severe duodenal ulcer bleeding and failure of endoscopic hemostasis with hemodynamic instability were submitted to surgery and included in this study.

During surgery anterior gastroduodenotomy through the pylorus to expose the bleeding site was made. The index finger was introduced into the omental vestibule through the omental foramen to obtain a decrease in local bleeding (Figs. 1, 2, 3). The finger was directed in a

Fig. 2 Giant posterior hemorrhagic duodenal ulcer in a patient seen after an anterior gastroduodenotomy. The dissecting forceps indicates a visible bleeding vessel controlled by digital posterior compression

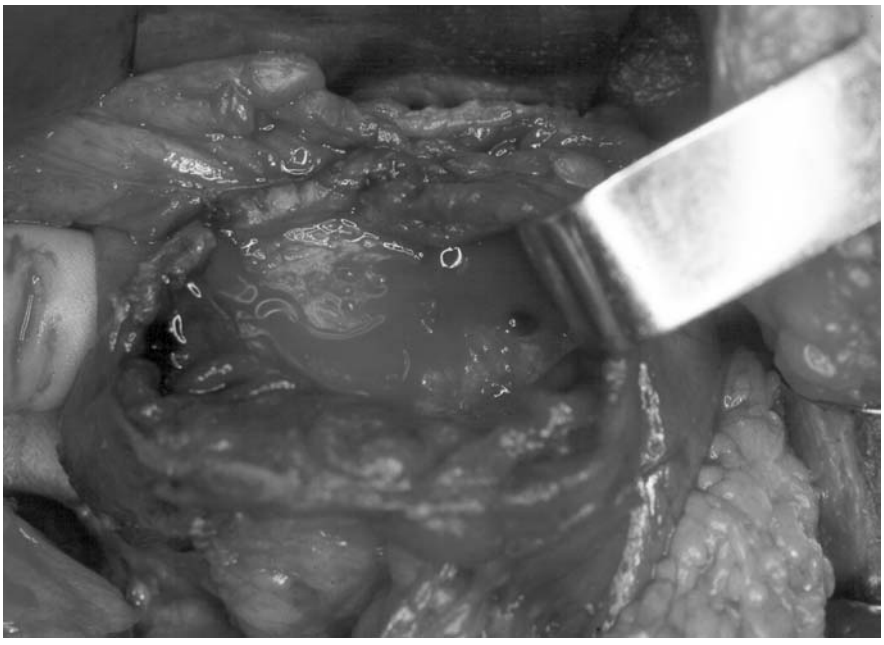

Fig. 3 The same case as in Fig. 2. Bleeding increases when digital compression is relieved

downward and forward direction with direct postero-anterior pressure of its tip along the posterior wall of first part of the duodenum. This intraoperative maneuver decreased local hemorrhage, and allowed the surgeon to clearly identify the bleeding site and ligate the bleeding artery. Truncal vagotomy and pyloroplasty completed the intervention according Weinberg [15].

Study in cadavers

To explain the described surgical procedure already successfully performed in patients we studied its anatomical basis in cadavers.

Twenty-four fresh blocks of normal tissue composed of diaphragm, esophagus, stomach, duodenum, pancreas, spleen and liver were removed from cadavers during autopsies and after previous consultation with RENNDA (REgisto Nacional de Não Dadores), an official Portuguese registration board where all non-donors are registered. Persons not registered are all potential donors.

The blocks of the 24 cadavers were obtained by sectioning the diaphragmatic insertions near their origins from the sternum, ribs and vertebrae. The aorta was sectioned near its arch with the esophagus and above its bifurcation.

Detachment of the organs was made along the retroperitoneal space, along the plane of the posterior layer of the renal fascia, near psoas major and quadratus lumborum muscles. Jejunum was sectioned 1 m from the duodenojejunal junction. The celiac trunk was identified and the common hepatic artery was cannulated. The right gastroepiploic and the superior mesenteric arteries were ligated at their origins. The arterial network was irrigated with saline solution at 37 °C and 50 ml red-colored silicone rubber was injected through the hepatic artery origin. After 2 h in a cool chamber the hepato-esophageal and hepato-gastric ligaments were divided. The common and proper hepatic arteries were identified and dissected (Fig. 4). An anterior gastroduodenotomy across the pylorus was performed, followed by a posterior incision along the posterior surface of the duodenum to identify the GD artery (Fig. 5). In all specimens permeability of omental foramen was evaluated and the distance between the GD artery and the inferior border of the omental foramen was measured.

Results

In patients

The permeability of the omental foramen was verified in all patients. A finger introduced through this foramen can easily and quickly reach the posterior surface of the first part of the duodenum.

Duodenal ulcer bleeding control was easily and quickly obtained in all the operated patients with the previous described maneuver (Figs. 2, 3). The surgeon was able to obtain safe suture control with no apparent bile duct lesion.

In cadavers

The permeability of the omental foramen was verified in all cadaver specimens. A finger introduced through that foramen reaches the posterior surface of duodenum's first part easily and rapidly.

The hepatic artery arose from the celiac trunk in all cases. It had an average diameter of 5.1 ± 0.82 mm

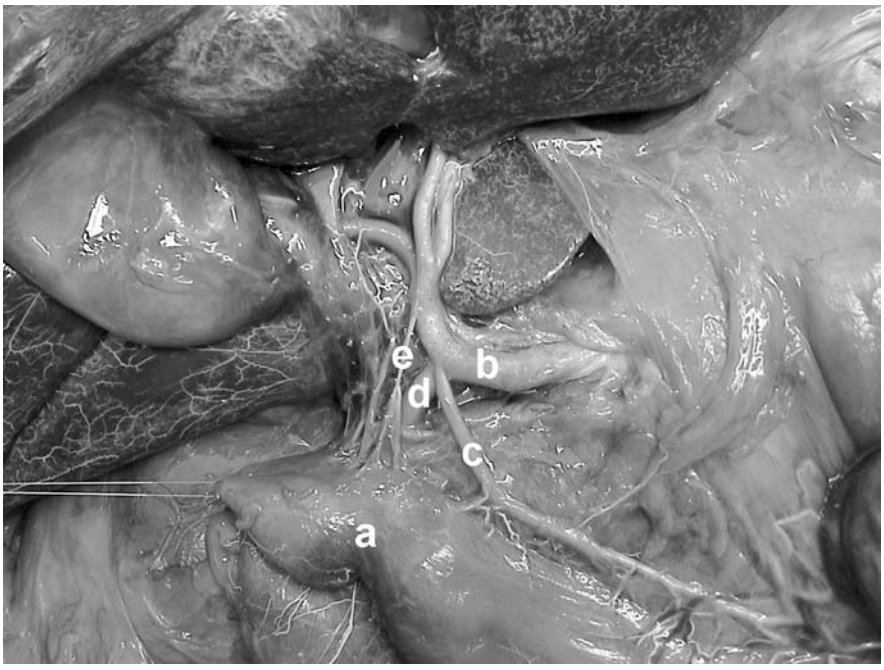

Fig. 4 Block of a cadaver injected with red-colored silicon rubber. *a*, Pylorus; *b*, common hepatic artery; *c*, right gastric artery; *d*, GD artery; *e*, suprapyloric artery

Fig. 5 Block of a cadaver injected with red-colored silicon rubber. An anterior gastroduodenotomy along the pylorus was performed, followed by a posterior incision on duodenum posterior surface to identify the GD artery (*a*). *b*, Common hepatic artery; *c*, right gastric artery

(range 4.6–5.5 mm). The artery ran initially along the upper border of the first part of the duodenum in a forward and rightward direction. Here it ascended to the porta hepatis between the layers of lesser omentum, anterior to the omental foramen.

The GD artery arose from the common hepatic artery above the duodenum's superior border (19 cases) or behind its first part (5 cases). In one case the GD artery arose from the hepatic artery near its termination (Figs. 6, 7).

The GD artery descended behind the duodenum and then between the duodenum and the neck of the pancreas. At the lower border of the duodenum, the GD artery divided into the right gastroepiploic and anterior superior pancreaticoduodenal arteries. The distance between the origin of the GD artery and the pylorus was 2.8 ± 0.75 cm (range 1.8–4.3 cm) (Table 1).

The origin of the GD artery was situated on the left side of common bile duct and progressively separated from it along its course in 20 cases (80%), which corresponds to type I according to Prudhomme's classification [13]. In the other four cases (17%) the GD artery and the common bile duct were close together but did not cross each other (type II).

The average distance between the omental foramen and GD artery origin was 3.3 ± 0.34 cm (range 2.8–3.8 cm) (Table 2).

The posterior superior pancreaticoduodenal (PSPD) artery arose 1.7 ± 0.19 cm (range 1.4–2.0 cm) on average from the GD artery origin (Table 3) and from the suprapancreatic portion of GD artery in our cases. The PSPD artery descended obliquely behind the posterior surface of the duodenum's first part, crossing the suprapancreatic common bile duct anteriorly. The PSPD artery reached the posterior surface of the

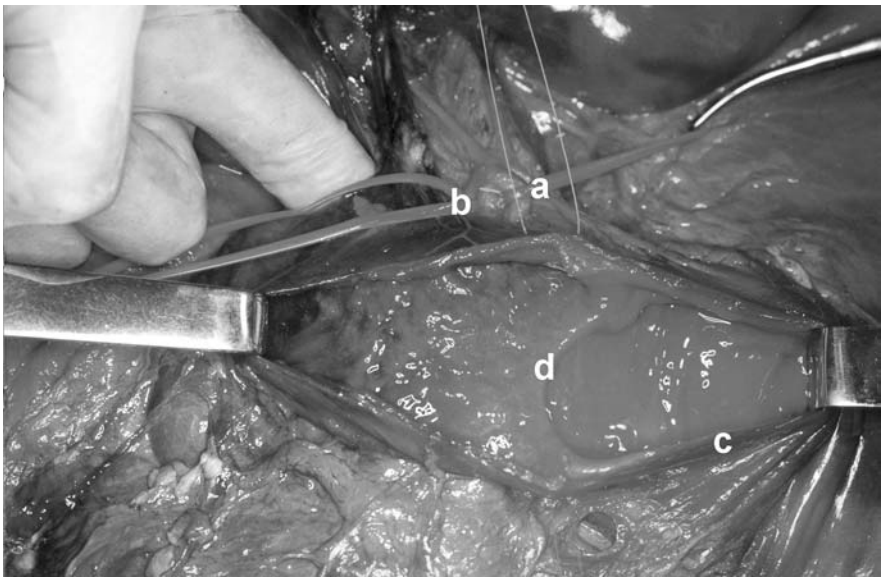

Fig. 6 Block of a cadaver injected with red-colored silicon rubber. A finger introduced into the omental vestibule through the omental foramen easily reaches the GD artery behind the duodenum. *a*, Common hepatic artery; *b*, GD artery; *c*, anterior gastroduodenotomy; *d*, pylorus

pancreas and ended by anastomosing with the posterior inferior pancreaticoduodenal artery.

Discussion

Behind the first part of the duodenum there are two main arteries: the GD and PSPD arteries [1, 5, 13]. In our dissections the GD artery arose from the hepatic artery above the first part of the duodenum (79% of cases), which is concordant with other reports [8, 13]. The GD artery descended just behind the posterior surface of duodenum located 3.2 cm from the right side of the pylorus. Here a posterior duodenal ulcer can erode the vessel. Near the inferior border of the duodenum, behind its posterior surface, there is, however, sometimes a layer of pancreatic tissue, which protects the artery [13]. We did not confirm this in our cases.

The common bile duct presents different kinds of relationships with the GD artery. In our cases the GD artery descended parallel to the common bile duct's left side, relatively close to it. Some authors, however, describe cases where the common bile duct and the GD artery cross each other [8, 13]. This arrangement can be dangerous during surgical treatment of massively bleeding duodenal ulcers.

The PSPD artery is usually a branch of the GD artery, but it can arise from the hepatic artery according to some authors [5, 13]. The PSPD artery usually arises from the GD artery behind the first part of the duodenum [1, 8]. The PSPD artery descends transversely to the right side and then crosses the anterior surface of the

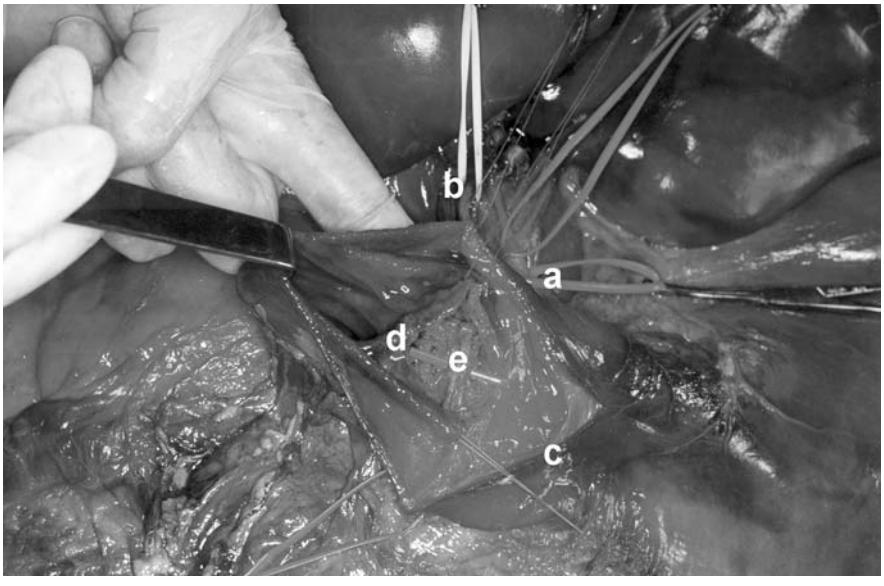

Fig. 7 Block of a cadaver injected with red-colored silicon rubber. A finger introduced into the omental vestibule through the omental foramen easily reaches the gastroduodenal artery behind the duodenum. *a*, Common hepatic artery; *b*, common bile duct; *c*, anterior gastroduodenotomy; *d*, duodenal posterior surface section to see the GD artery (*e*)

Table 1 Distance between the gastroduodenal artery origin and the pylorus

Subject no.	Distance (cm)
1	2.0
2	2.7
3	2.1
4	2.8
5	3.8
6	3.6
7	2.5
8	1.8
9	2.8
10	3.3
11	3.8
12	1.9
13	2.0
14	2.6
15	2.1
16	2.3
17	4.3
18	2.4
19	3.0
20	2.6
21	4.0
22	3.4
23	3.6
24	1.9

Table 3 Distance between the gastroduodenal artery origin and the posterior superior pancreatoduodenal artery origin

Subject no.	Distance (cm)
1	2.0
2	1.5
3	1.6
4	1.9
5	1.7
6	1.9
7	1.5
8	1.6
9	2.0
10	1.4
11	1.8
12	1.5
13	1.8
14	1.4
15	2.0
16	1.7
17	1.6
18	1.7
19	1.5
20	1.7
21	1.9
22	1.7
23	1.4
24	1.6

lowest portion of the suprapancreatic common bile duct [1, 5, 8]. Bertelli et al. [1] described some normal variations of the PSPD artery and the common bile duct relations, which may be very important in surgical practice.

When a bleeding ulcer is situated near the pylorus, the artery most often responsible for the hemorrhage is the GD artery [13]. But when the ulcer is located in the second half of the first part of the duodenum, the PSPD artery is the vessel responsible for the hemorrhage, which will be theoretically weaker because the PSPD artery's caliber is inferior to that of the GD [1]. The distance between the omental foramen and the GD artery behind the duodenum is 3.2 cm on average and thus is quite accessible to digital compression.

Table 2 Distance between the gastroduodenal artery origin and the omental foramen

Subject no.	Distance (cm)
1	2.8
2	2.9
3	3.6
4	3.2
5	3.0
6	3.5
7	3.4
8	3.8
9	3.5
10	3.8
11	3.6
12	2.8
13	3.4
14	2.8
15	3.3
16	3.3
17	3.0
18	3.6
19	2.8
20	3.0
21	3.4
22	3.7
23	3.7
24	3.0

During the surgical treatment of massive hemorrhage from a duodenal ulcer, after anterior duodenotomy, it is essential to decrease local bleeding to allow the surgeon to precisely identify the site of the hemorrhage and prevent common bile duct lesions during GD or PSPD artery suture. To decrease bleeding we introduced a finger through the omental foramen. This very simple procedure compresses the GD and PSPD arteries from behind against the duodenum's posterior surface, obtaining a decrease in the hemorrhage. During this easy maneuver the surgeon can efficiently ligate the bleeding vessel to secure hemostasis with a low risk of a common bile duct lesion. This procedure is easier and faster to perform than the retroduodenopancreatic detachment proposed by Mutter and Marescaux [11], especially in an obese patient with hemodynamic instability. Also, according Weinberg [15], mobilization of the duodenum should be avoided as it may cause tears in the inflamed duodenum and formation of obstructing adhesions.

Conclusions

The GD artery is the main artery behind the first part of the duodenum, situated 3.2 cm from the left side of the omental foramen. The GD artery can be eroded by a duodenal ulcer, sometimes causing a massive

hemorrhage, treatable only by surgery. Usually these patients are hemodynamically unstable, requiring urgent surgical treatment to ligate the bleeding vessel.

During the operation, when massive hemorrhage makes a hemostatic suture very difficult, the surgeon may simply introduce his index finger into the bursa omentalis vestibule, through the omental foramen, directed downward and forward against the posterior surface of the duodenum, to decrease the hemorrhage by GD artery compression.

This easy procedure allows the identification of the exact site of the hemorrhage and enables quick and definitive suture hemostasis, especially in a critical patient. Apart from decreasing the bleeding it also can reduce the risk of a common bile duct lesion during the suture procedure.

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