Hepatobiliary & Pancreatic Diseases International xxx (xxxx) xxx

Contents lists available at ScienceDirect

Hepatobiliary & Pancreatic Diseases International

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Clinical Images

Timely synergic surgical and radiological aggressiveness improves perioperative mortality after hemorrhagic complication in Whipple procedure

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Pancreaticoduodenectomy (PD) is a surgical procedure that exposes the patients to a wide range of postoperative complications that can also be lethal. Postoperative pancreatic fistula (POPF), delayed gastric emptying (DGE) and postpancreatectomy hemorrhage (PPH) are among the most common. PPH has a lower incidence (3%–16%) [1] compared to POPF (3%–45%) [2] and DGE (19%–57%) [3], but it is burdened by a high mortality rate (16%–36%) [4,5]. The management of this complication is particularly demanding, and it needs the close cooperation of multidisciplinary teams: the pancreatic surgeon, the interventional radiologist, and the endoscopist. Although sometimes the severity of this condition seems overwhelming, the combination of multiple procedures can limit the morbidity and mortality related to PPH. The present study aimed to describe the postoperative course of a patient who underwent PD for periampullary adenocarcinoma at our institution and received three emergency laparotomies and three radiological procedures to successfully manage a grade C PPH.

A 73-year-old male presented at a local hospital with obstructive jaundice. A thoracoabdominal enhanced CT showed a periampullary neoplasm without metastatic disease. Endoscopic retrograde cholangiopancreatography with papillosphincterotomy, multiple biopsies, and distal common bile duct stenting were performed. The pathological assessment of the biopsies was positive for ductal adenocarcinoma. The patient was then transferred to our hospital where he underwent a laparotomic PD with telescopic pancreaticojejunostomy performed with two resorbable running sutures; the pathological examination pointed out a signet ring cell carcinoma infiltrating the pancreatic parenchyma and the duodenal wall (stage III - pT3N2M0R0). A biochemical leak was demonstrated during the early postoperative course by hyperamylasemia in the perianastomotic drain's fluid (4440 UI/L at POD 5). At POD 6 a sentinel-bleed in the surgical drains appeared; an urgent contrast-enhanced CT (CeCT) scan confirmed hemoperitoneum. The patient rapidly became hemodynamically unstable. He was transferred to the theater for emergency laparotomy. Bleeding arising from a proper hepatic artery laceration at the origin of the pyloric artery was revealed and immediately sutured (Fig. 1A). A chemical pancreatectomy with Policloroprene was also performed to reduce the risk of further POPF. Nonetheless, pancreatic fluid was still detected in surgical drains postoperatively. At POD 17 the patient suffered from hematemesis associated to sudden drop of systolic blood pressure and increasing heart rate. Due to the hemodynamic instability, we deemed a surgical approach crucial. Another attempt to suturing the hepatic artery (source of bleeding), was made. A distal splenopancreatectomy was realized simultaneously. During this procedure, the splenic artery was isolated, preserved for 8 cm, and overturned from its origin to perform a vascular reconstruction in case of further bleeding. At POD 28 the patient experienced PPH once again with multiple episodes of hematemesis and presence of blood in surgical drains rapidly leading to hemorrhagic shock. For this reason, urgent surgery was the only viable approach. The hemorrhage originated again from a complete disruption of the previously sutured proper hepatic artery. This time, the common hepatic artery was tied close to its origin and the distal stump was trimmed. The subsequent shortage of the vessel precluded any chance to suture the two stumps of the hepatic artery. Therefore, an end-to-end anastomosis with a 7/0 Prolene running suture between the stump of the splenic artery and the proper hepatic artery was realized (Fig. 1B and Fig. 2); a nutritional jejunostomy was put in place as well. An intraoperative color Doppler ultrasonography showed a satisfying intrahepatic arterial blood flow confirming the patency of the anastomosis.

Despite the great surgical effort, hematemesis newly appeared at POD 44; due to stable hemodynamic, a CeCT was performed showing arterial blush from the tied stump of the native hepatic artery. The patient immediately underwent angioembolization of the ligated native proper hepatic artery stump with coils (Ruby Coil, Penumbra®, Alameda, CA, USA) and stenting of the vascular anastomosis with a fully-covered stent (8 mm, Gore®, Viabahn Endoprothesis, Flagstaff, AZ, USA) occluding the proper hepatic artery stump ostium; no active bleeding was seen at the end of the procedure (Fig. 3A). Hematemesis and sentinel bleed in the surgical drains rapidly reappeared at POD 47. No arterial blush was seen at

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https://doi.org/10.1016/j.hbpd.2020.12.003
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Please cite this article as: A. Chierici, M. Intotero, S. Granieri et al., Timely synergic surgical and radiological aggressiveness improves perioperative mortality after hemorrhagic complication in Whipple procedure, Hepatobiliary & Pancreatic Diseases International, https://doi.org/10.1016/j.hbpd.2020.12.003

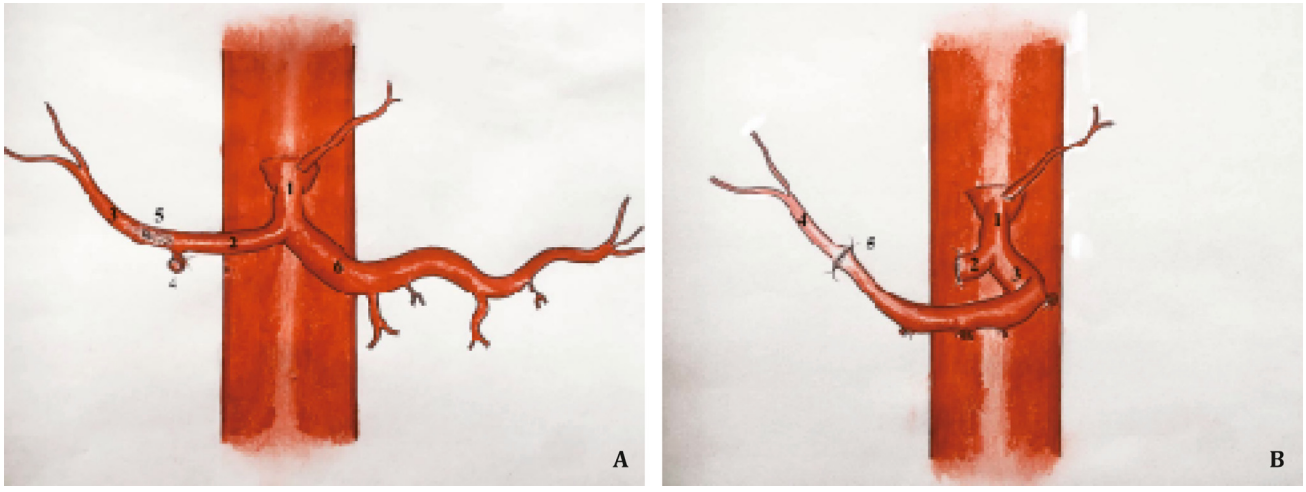

Fig. 1. A: The celiac trunk after the first relaparotomy (1. celiac trunk; 2. common hepatic artery; 3. proper hepatic artery; 4. ligated gastroduodenal stump; 5. sutured hepatic artery laceration; 6. splenic artery). **B:** The celiac trunk after the third relaparotomy (1. celiac trunk; 2. ligated common hepatic artery; 3. splenic artery; 4. proper hepatic artery; 5. end-to-end spleno-hepatic anastomosis).

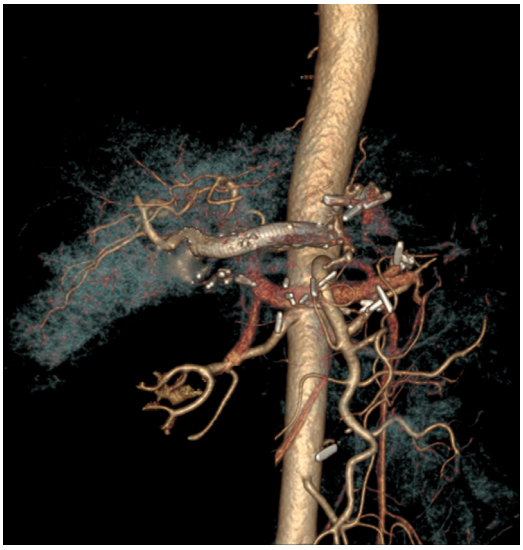

Fig. 2. 3D contrast-enhanced CT scan reconstruction of the spleno-hepatic end-to-end anastomosis.

CeCT, but hemorrhagic effusion surrounded the vascular anastomosis. A centimetric pseudoaneurysm of the right hepatic artery, just distally to the anastomosis was spotted during angiography. Therefore, another fully covered stent in the right hepatic artery, occluding the pseudoaneurysm, was placed (Fig. 3B). At POD 70 the patient was finally discharged after progressive recovery and no other episodes of bleeding. The patient was admitted again to our hospital 13 days after discharge for a new episode of abundant hematemesis. After fluid resuscitation, he sustained gastroscopy that was unable to find the origin of the bleeding. Thus, he received a new angiography that highlighted hemorrhage from a new pseudoaneurysm of the proper hepatic artery, downstream of the previously placed stent (Fig. 3C). Another covered vascular stent was positioned with complete exclusion of the pseudoaneurysm (Fig. 3D). The patient was then discharged at POD 92 with no other recurrences of bleeding.

The occurrence of PPH is a feared complication of PD with an incidence up to 16%. According to the International Study Group of Pancreatic Surgery definition [1], PPH is defined by three main criteria: time of onset, location, and severity, that allow to identify grades A, B, and C PPH. While for grade A PPH, morbidity and mortality are not different from uncomplicated PD, grade B and grade C PPH expose the patient to an increased risk of unfavorable outcomes [6]. The bleeding frequently arises from the gastroduodenal stump, the hepatic artery, or some tributaries of the superior mesenteric artery [1]. The pathophysiology of this complication is unclear: it is normally ascribed to the digestion of the arterial wall caused by pancreatic fluids in case of POPF, the surgical injury provoked by unsuccessful hemostasis, or close intimal dissection while performing lymphadenectomy [6]. This can result in a direct arterial loss of continuity leading to an early PPH or to the formation of a pseudoaneurysm that can bleed belatedly. For this reason, many different surgical and non-surgical options have been proposed. Variations of the reconstruction and anastomosis techniques, Wirsung stenting, pancreatic stump closure, drain positioning and the use of somatostatin analogs have been experimented to reduce the rate of PPH and POPF but still with poor results [7]. A special mention must be made for the omental or falciform ligament wrapping that seems to slightly reduce both PPH and clinically relevant POPF [8].

The treatment of PPH is often heavily demanding and time-dependent. Interventional radiology, endoscopy, and surgery represent the cornerstones in the management of the bleeding that must be identified rapidly [9]. At our institution, endoscopic and radiologic management of PPH is always preferred whenever possible: these procedures are less demanding for the patient and can often achieve the same results of surgery with a lower rate of procedure-related complications. The possibility to rely on endoscopy and interventional radiology often depends on patient's hemodynamics. In our clinical case, the experience of surgeons trained in liver transplantation, with expertise in complex arterial reconstructions, allowed the achievement of a successful outcome. Similarly, the high expertise gained over the years by interventional radiologists of our center in the endovascular treatment of traumatic arterial injuries has allowed managing the hemorrhagic complication even when surgery was not pursuable. The treatment of PPH, although immediately successful, is often not definitive with literature reported re-bleed rate around 10%–30% [10]. The need for reintervention increases the risk of death compared to patients undergoing an uncomplicated PD with no change in overall and disease-free survival [11]. The effectiveness of surgical reintervention decreases proportionally with the number of procedures from 60% for the first reintervention to 50% in case of a second relaparotomy [12].

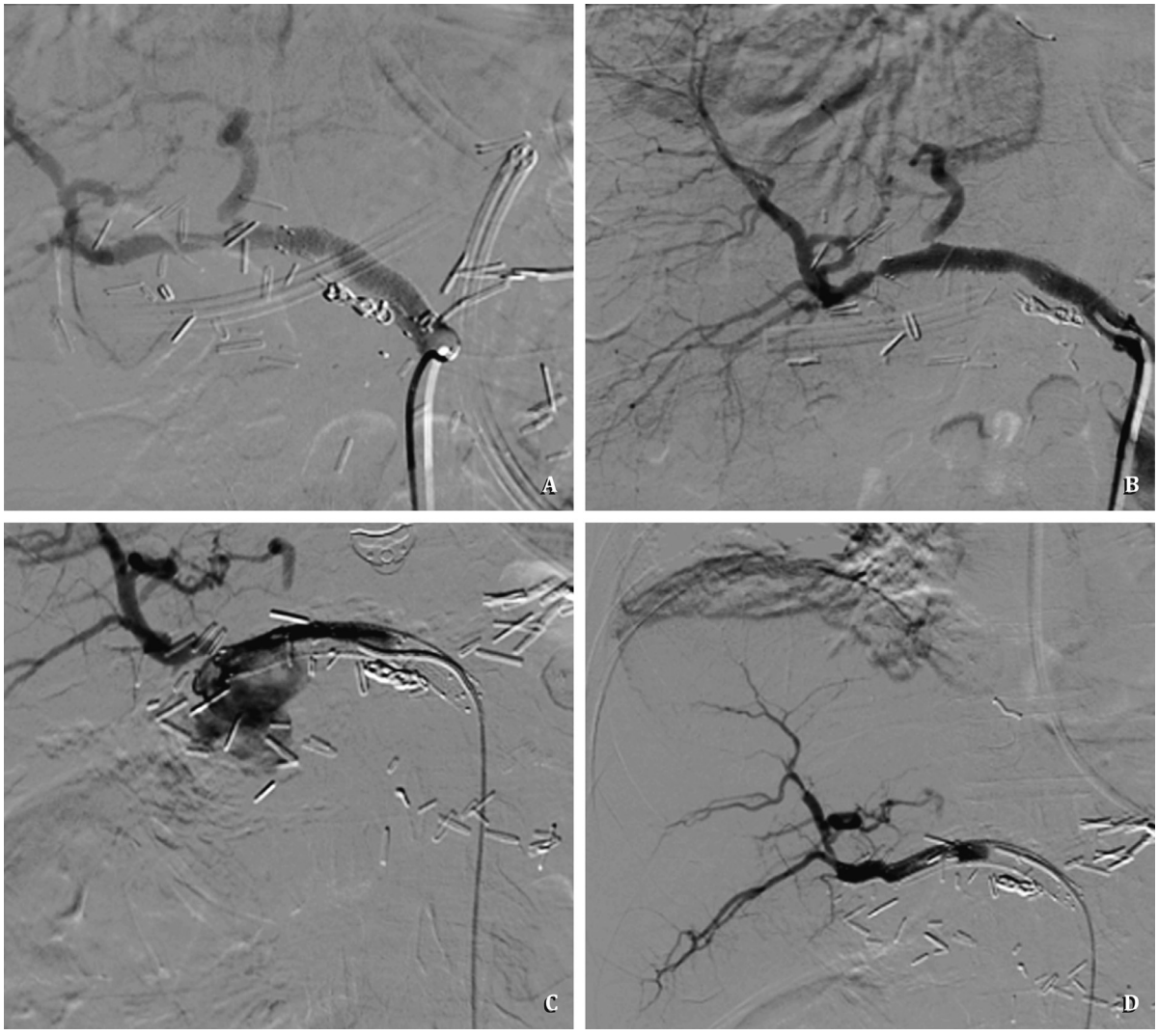

Fig. 3. A: Native hepatic artery stump embolization and vascular anastomosis stenting. **B:** Right hepatic artery stenting for pseudoaneurysm. **C:** Right hepatic bleeding pseudoaneurysm distally from the previous placed covered stent. **D:** Right hepatic pseudoaneurysm covered stenting.

Despite frequent complications of PD, there is a lack of evidence in the literature about multiple reinterventions for PPH. Moreover, the optimal strategy to adopt in case of post-PD bleeding is unclear. Whether to follow a minimally invasive approach (radiological/endoscopic) rather than a new surgical procedure often depends on the simultaneous need to control other associated complications (e.g. POPF) or the hemodynamic status of the patient. Furthermore, in case of rebleeding, there is no evidence of which approach is to be preferred. Anyway, the mainstay of management of this condition is represented by early detection of bleeding.

To our knowledge, this is the only reported case of a patient who underwent six different procedures to successfully manage a late, grade C PPH. Despite the poor prognosis burdening this kind of complication [13], the present report is an example of how an aggressive interventional behavior can successfully cope with a lethal complication. In this setting, the close cooperation among surgeons, endoscopists and interventional radiologists can lead to remarkable results.

Acknowledgments

None.

CRediT authorship contribution statement

Andrea Chierici: Conceptualization, Writing - original draft. **Marcello Intotero:** Conceptualization. **Stefano Granieri:** Writing - review & editing. **Sissi Paleino:** Visualization. **Giovanni Flocchini:** Supervision. **Alessandro Germini:** Validation. **Christian Cotsoglou:** Conceptualization, Project administration, Validation, Writing - review & editing.

Funding

None.

Ethical approval

Informed consent for publication was obtained from the patient.

Competing interest

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

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Received 25 June 2020
Accepted 26 October 2020
Available online xxx