Role of Emergency Laparoscopy in Surgical and Endoscopic Complications

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1 Introduction

Post-procedural complications are inherently linked with any surgical or endoscopic procedure. The reported incidence rates are highly varying and depend mostly on the type of the index intervention and the definitions adopted for each complication [1]. Postoperative adverse events increase in-hospital costs up to five times when compared with similar operations without complications [2]. Explorative laparoscopy is an alternative to conventional laparotomy for patients with suspected early abdominal complications. It can be especially useful when the physical examination and the radiologic tests are inconclusive. A primary or a repeated laparoscopic procedure can be both used to obtain a prompt and definitive diagnosis and to treat most of these complications, especially when control of a septic focus is needed [3, 4]. Compared with the performance of a standard laparotomy, the use of laparoscopy in the emergency setting reduces the postoperative pain, time to recovery, wound infections, ileus, and incisional hernia rates while also improving cosmesis [4]. A

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mini-invasive approach also has less operative trauma and a lower systemic stress response [5]. Even if the prior approach was open, performing a second-look evaluation using laparoscopy has demonstrated to be safe and effective [6].

However, up to 25% of the re-laparoscopies are negative [7]; so a significant number of patients are subjected to an unnecessary surgical risk. Certain situations should preclude surgeons from creating a pneumoperitoneum, such as the presence of hemodynamic instability or severe respiratory failure [8]. Moreover, other conditions hinder the application of minimally invasive therapies but are not considered absolute contraindications. They are (1) severe bowel dilatation, (2) multiple and firm adhesions (the "frozen abdomen"), (3) diffuse peritonitis, (4) massive hemorrhage, and (5) extensive mesenteric ischemia [9]. The risk of iatrogenic injury to abdominal organs is the major drawback of emergency laparoscopy. This is facilitated by the intense inflammation of the tissues and the presence of multiple adhesions, which hampers the proper identification of the anatomical structures.

Laparoscopic reinterventions are most frequently undertaken to manage early postoperative complications after colorectal surgical procedures like anastomotic leak, bowel obstruction, or bleeding [4]. Postoperative hemorrhage following abdominal surgery is a potentially life-threatening complication. The use of laparoscopy is a reasonable option in stable patients, but in hemodynamically unstable patients, a laparotomy would be mandatory. When a bleeding source is not found laparoscopically, a prompt conversion to an open approach minimizes the risk for future adverse events. To localize the origin of the hemorrhage can be hazardous if dense clots or severe inflammation are present, but success rates are promising if the surgery is carried on by expert teams [10].

A mechanical bowel obstruction is an infrequent condition in the early postoperative period following laparoscopic surgery. Trocar site hernias are the most common cause [11]. They can be managed through the trocar site, by a re-laparoscopy, or by laparotomy. Diagnostic laparoscopy allows evaluation of the intestine in cases with suspected Richter's hernia, avoiding the need of a laparotomy [12]. Laparoscopic adhesiolysis after an open procedure could be an option for surgeons, but few series have been reported [4]. This approach is not recommended in cases with massive abdominal distension or in those presenting with signs of peritonitis [13].

2 Complications After Colorectal Surgery

2.1 Incidence and Risk Factors

Colorectal resections are associated with high postoperative complication rates; they can be detected in up to 50% of the patients [14]. The most important within them are anastomotic leak (AL), surgical site infection, bleeding, hollow viscus perforation, intestinal obstruction, ischemia, and urologic injuries [15]. AL is the main cause of reoperation following colorectal surgery; its incidence ranges within 3–30% depending on the series [16]. In 2010, the International Study Group of Rectal Cancer graded AL in a three-tiered system based on the aggressiveness of the

treatment needed: (a) AL requiring no active therapeutic intervention, (b) AL requiring active therapeutic intervention but manageable without a relaparotomy, and (c) AL requiring a re-laparotomy [17]. Years ago, nearly all ALs were treated through a laparotomy. However, surgeons have been continuously improving their laparoscopic skills, and the indications to operate on colorectal postoperative complications using a laparoscopic approach have increased.

2.2 Anastomotic Leaks

Depending on the type of procedure and the anastomosis initially performed, different mini-invasive surgical operations could be performed when AL is suspected or detected. For ileocolic AL, the laparoscopic approach is rarely used, since these cases are usually accompanied by severe septic conditions. However, in small leaks without extensive contamination, an explorative laparoscopy, anastomosis repair, and proper lavage and drainage of the abdominal cavity could be an affordable option. If a wide anastomotic defect is found, redoing the anastomosis would be mandatory. A diverting ileostomy can be also performed depending on the patient's characteristics and the clinical status. Colorectal AL presenting with a wide defect causing diffuse peritonitis and/or colonic ischemia usually requires the resection of the anastomosis and the performance of a terminal colostomy (i.e., a Hartmann's procedure). This should be accompanied by a profuse lavage and drainage of the cavity. However, in smaller defects, surgeons should make the choice between fixing or redoing the anastomoses. In the latest years, with the rise of trans-anal minimally invasive surgery (TAMIS), a new tool has emerged to evaluate and to repair colorectal AL located between 5 cm and 15 cm from the anal verge. The procedure would consist of the debridement of the leak edges and then re-suturing through the TAMIS access. The technique has shown to be safe and effective, especially if it is undertaken during the first five postoperative days [18]. A coloanal anastomosis can be similarly repaired under direct visualization or using a conventional anoscope [6]. If not performed at the first operation, a diverting ileostomy can be helpful to shorten the time to resume the oral intake.

2.3 Other Complications

Different teams have demonstrated that a laparoscopic approach can be useful to treat other complications like (a) bowel injuries with a primary repair; (b) complete ureteric transections by end-to-end anastomosis; (c) bowel obstructions by either lysis of adhesions or reducing internal hernias; and (d) hemostasis by coagulation, endo-loop application, clipping, suturing, or using hemostatic agents [19].

In these particular situations, the use of laparoscopy provides a faster resumption of oral intake and an earlier stoma function [20]. Its use may also shorten the intensive care unit (ICU) and hospital stays [21]. Moreover, the number of stomas that can be definitively reconnected after a laparoscopic emergency management is

higher than for open surgery [22]. Sometimes, the technical difficulty does not allow to complete the reoperation by laparoscopy, and conversion is required. Such a conversion is related with more severe postoperative pain, longer hospital stays, and higher rates of ileus and wound infection [10]. Even so, an initial minimally invasive approach permits some progress of control of the complication which could prevent larger incisions if conversion is required. Finally, while the diagnosis and treatment of these complications using a laparoscopic approach are often technically feasible, the surgeons should make the choice to undergo reoperative laparoscopy depending on the experience of the whole surgical team and the availability of the different technologic resources, thus individualizing each singular case.

3 Complications After Other Surgical Procedures

3.1 Upper Gastrointestinal Surgery

Anastomotic leaks after upper gastrointestinal resections are associated with high morbidity and mortality. For small controlled leaks, a conservative treatment based on broad-spectrum antibiotics and percutaneous drainage with or without endoscopic stenting are the ideal choice [23]. Literature reports focusing on the use of minimally invasive surgical approaches in these situations have been anecdotal to date. Laparoscopic washout followed by the placement of a percutaneous trans-anastomotic suction tube has been described [24]. The laparoscopic repair also constitutes an alternative for iatrogenic gastric perforations that occurred during other laparoscopic operations [5, 10]. Similarly, early complications after laparoscopic anti-reflux surgery can be treated by the same mini-invasive approach. If the complication is early, such as paraesophageal herniation or severe dysphagia, a laparoscopic revision of the anti-reflux procedure would be an option, ideally within the first seven days [25, 26].

3.2 Hepatobiliary Surgery

Minimally invasive reinterventions after cholecystectomy are frequently due to postoperative bleeding or bile duct injuries. Bleeding after cholecystectomy or liver resection can be managed laparoscopically [27, 28]. Bile duct injury is the most feared complication of cholecystectomy; they are classified according to the system proposed by Strasberg [29]. Percutaneous drainage and endoscopic stenting are usually the first steps to treat biliary and cystic leaks (Strasberg A, C and D) [30]. In selected cases, a postoperative laparoscopy can be undertaken to confirm the diagnosis, to achieve sepsis control, or to perform a definitive repair. A re-laparoscopy to gain sepsis control with extensive abdominal washout and drain placement has been performed in small injuries and minor leaks from the cystic stump or small accessory ducts from the gallbladder bed (Luschka's) [31, 32]. Although few cases are found in the literature, a laparoscopic reconstruction after major bile duct injuries is feasible for highly experienced

teams [33, 34]. Robot-assisted, traditional laparoscopic, and open Roux-en-Y hepaticojejunostomy has been proposed as an alternative to repair complex injuries [35].

3.3 Appendectomy

Laparoscopic surgery in post-appendectomy complications has been used to drain intra-abdominal abscesses, to extract retained fecaliths, and to manage stump appendicitis or postoperative bleeding. The most common treatment for the first of them is to administer intravenous antibiotics, adding or not a percutaneous drainage of the fluid collections. If failure of the previous, or in those patients presenting with multiple abscesses, a laparoscopic exploration could be an alternative to laparotomy [36]. Different teams have evaluated the role of early laparoscopic washout in these situations. They considered it to provide an earlier resolution of the sepsis, when compared with the percutaneous or open approaches [37]. It has been proposed that a re-laparoscopy is the first choice for abscesses detected within the first seven days after the index procedure [38], especially if the sepsis cannot be controlled by drainage and antibiotics alone. Stump appendicitis is an infrequent complication following appendectomy. A new laparoscopic exploration would be the best chance to confirm the diagnosis and to complete the removal of the appendix [39].

3.4 Urologic Surgery

The role of re-laparoscopy after minimally invasive urologic procedures is very limited; the largest case series only included 12 patients [40]. Redo-laparoscopy due to bleeding is the most frequently performed procedure [41].

4 Iatrogenic Perforations During Colonoscopy

4.1 Background

Colorectal perforations complicating lower gastrointestinal endoscopic procedures are deleterious events associated with important morbidity and mortality. Iatrogenic colonoscopy perforations (ICP) can be produced at both therapeutic and diagnostic procedures. The sigmoid colon is the most common site of perforation, but the presentation differs depending on several factors [42]. Half of the ICP are detected by the endoscopy operator during the procedure, and they are usually located intraperitoneally. Blunt trauma is considered the most frequent etiologic factor for ICP, producing larger perforations often located at the sigmoid colon. Conversely, excessive insufflation produces linear lacerations usually at the cecal region. Therapeutic procedures, such as mucosal/submucosal dissections, stricture dilatation, or stenting, present significant rates of ICP. Thermal injuries are linked with small and delayed ischemic perforations. The symptoms of ICP commonly start within 48 h after the

endoscopic procedure. To obtain an early diagnosis is critical for the patient's behavior, as delays greater than 24 h have been associated with the need for more invasive treatments [43]. The presence of extra-colonic free air at radiologic explorations confirms the diagnosis of ICP.

4.2 Surgical Management

The endoscopic closure is a useful option for ICP detected intra-procedurally. This should be followed by conservative treatment that consists of serial clinical and imaging monitoring with bowel rest, intravenous fluids, and broad-spectrum antibiotics. Close observation is required to detect the early development of peritonitis and/or sepsis indicating that the endoscopic repair may have failed. A similar approach can be used in patients with small and sealed-off perforations seen on CT scan. The failure of the conservative approach has been reported in up to 20% of the cases [46]. Therefore, the early success of a nonoperative management should not preclude close follow-up. Indications of surgery for ICP include the development of sepsis, signs of diffuse peritonitis, or in presence of large perforations not suitable to endoscopic closure. Surgery can be initially justified also in the presence of certain concomitant pathologies (e.g., unresected polyps with suspicion of carcinoma) [44, 45].

4.3 Role of Laparoscopy

Laparoscopic exploration has been increasingly used for ICP management. The intraoperative findings observed during a careful inspection of the whole peritoneal cavity would determine the choice between the different surgical alternatives. Surgeons should consider the characteristics of the perforation (e.g., size, degree of contamination, timing, mechanism) and the patient's features (e.g., comorbidities, general and sepsis status, presence of underlying lesions). Large perforations or associating mesocolon avulsions or unresected lesions should lead one to perform a colonic resection (with or without stoma formation). If no suspicious lesion remains after the endoscopy, and the ICP consists of a small tear in a healthy colon, a laparoscopic primary repair can be safely performed (Fig. 1). The World Society of Emergency Surgery (WSES) guidelines for the management of ICP, recently published, proposed that an explorative laparoscopy in the setting of ICP would be useful with diagnostic or therapeutic intention, depending on the surgeon's skills, the local resources, and the potential risks for definitive surgical procedures. Moreover, it can be applied also in cases of doubtful diagnosis, to rule out the need of further treatments (e.g., laparotomy) or if the endoscopic/conservative treatment is unfeasible or fails (e.g., sepsis or peritonitis development). Conversely, an

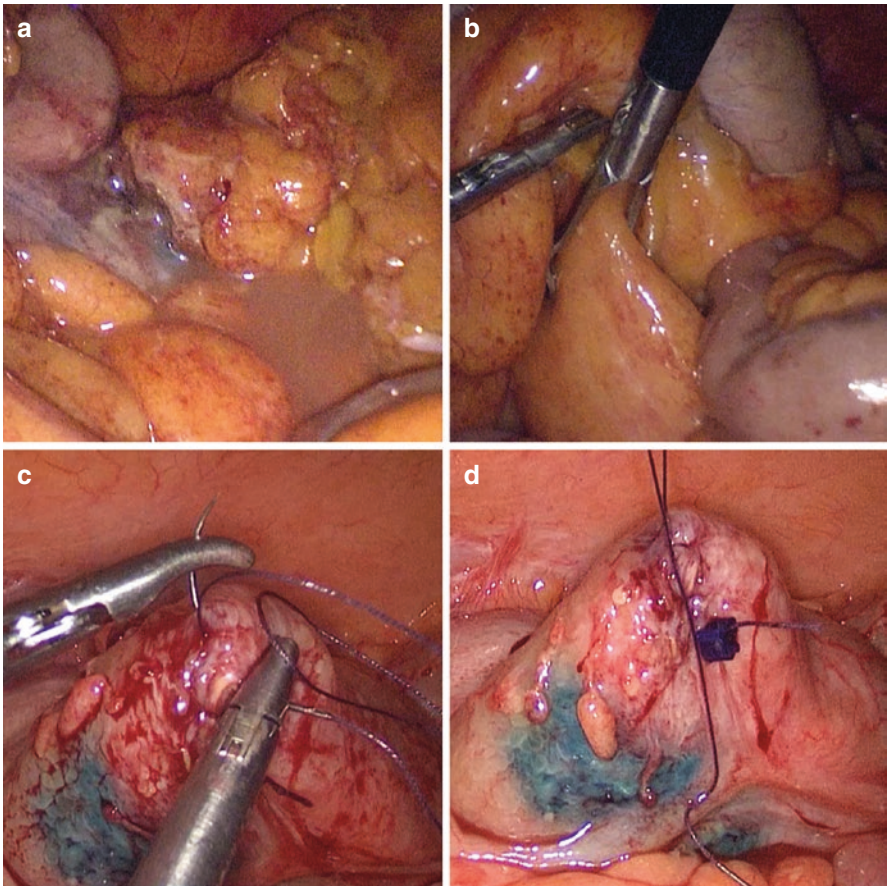

Fig. 1 (**a**, **b**) ICP perforation located in the right colon. Laparoscopic right hemicolectomy was performed. (**c**, **d**) Endoscopy-related cecal perforation treated with laparoscopic primary closure

explorative laparoscopy may not be indicated if the patient is hemodynamically unstable, if there is a potential risk for anesthesia-related complications, or if there are any contraindications for surgery in general (e.g., coagulopathy). Relative contraindications for this approach would be (1) recent laparotomy or more than four previous abdominal surgeries with extensive adhesions and high risk of iatrogenic injury, (2) massive bowel dilatation, and (3) aortoiliac aneurysmatic disease [42]. The most frequent causes of conversion are (1) the experience of the surgical team, (2) adverse surgical field conditions precluding the success of a laparoscopic procedure (e.g., contamination, large defects, inflammation, advanced cancer), and (3) patient's hemodynamic destabilization.

A recent systematic review with a meta-analysis including six studies published between 2008 and 2016 concluded that the laparoscopic approach appears to provide better postoperative results than open surgery in selected patients undergoing surgical management of ICP [46]. Overall, 90 patients underwent laparoscopic procedures due to ICP, with a conversion rate of 10%. Complications were observed in 18.2% of patients who underwent laparoscopy and in 53.5% of patients who underwent open procedures ($p < 0.001$). LOS was five days shorter for patients receiving less invasive procedures ($p < 0.001$). Noteworthy, the six included studies were considered to be at high risk of bias, and therefore, the quality of the evidence was judged to be low [47–52].

5 Iatrogenic Perforations During Upper Digestive Endoscopy

5.1 Esophageal Perforations

Iatrogenic harm is the most common cause of esophageal perforation. When they are secondary to diagnostic explorations, they are typically located at the upper portions. When they are due to sudden pressure increases, they are commonly found at the distal esophagus. Like ICP, nonoperative management can be undertaken in stable patients presenting with small perforations with minor contamination [53]. Explorative laparoscopy/thoracoscopy would be the first step in the surgical procedure depending on the surgical team skills and the available technological resources.

The minimally invasive repair of any esophageal perforations is technically hazardous in almost all possible scenarios. Therefore, it should be reserved to situations in which highly specialized expertise is available [54]. The surgical procedure should include the control of the sepsis with local debridement and the drainage of any collections. The primary closure of the defect could be attempted, but to assure adequate enteral support, feeding tube placement (e.g., nasogastric tube, gastrostomy, jejunostomy) is critical [53].

5.2 Complications Following Endoscopic and Percutaneous Gastrostomy

Gastric leak is a typical complication of patients with a gastrostomy. The laparoscopic repair of leaks following percutaneous or endoscopic gastrostomy has been

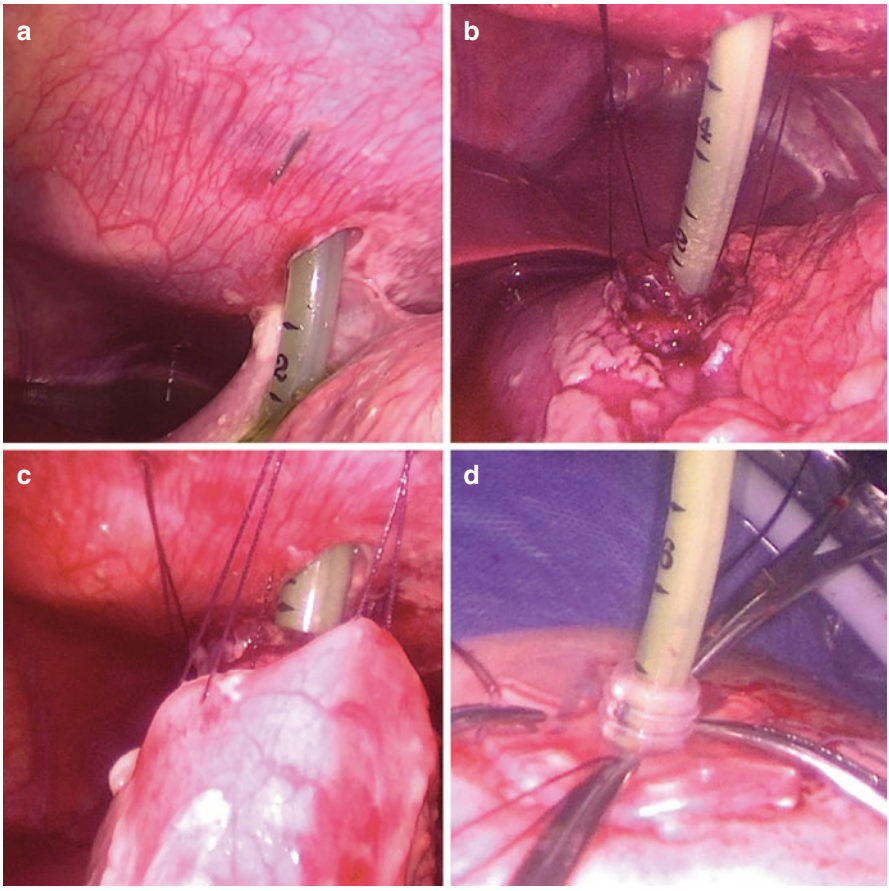

Fig. 2 (**a**) Percutaneous gastrostomy leakage as evidenced during explorative laparoscopy. (**b**, **c**) Laparoscopic gastropexy. (**d**) New external fixation of the plate

reported [5, 55]. This approach allows the surgeon to explore the entire abdominal cavity and to attach the stomach to the abdominal wall (Fig. 2). Another adverse event related to percutaneous gastrostomy is the buried bumper syndrome. This is an infrequent problem in which the internal bumper of the gastrostomy migrates into the stomach or the abdominal wall. Pediatric series have reported successful cases treated by laparoscopy [56].

6 Summary

Minimally invasive techniques can be employed in most cases of surgical or endoscopic complications. Early recognition and treatment are paramount, but there is a role for endoscopic correction of leaks or perforation. On the other hand, patients who are unstable, who have difficult abdomens, or who present important comorbidities, like a coagulopathy, should be managed in the most expeditious way, which typically means an open technique. If the situation can be handled with laparoscopy, the patients will usually have fewer complications.

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