**Name of Journal: World Journal of Gastroenterology**

**ESPS Manuscript NO: 22892**

**Manuscript Type: TOPIC HIGHLIGHTs**

**2016 Laparoscopic Surgery: Global view**

**Laparoscopic approach in gastrointestinal emergencies**

Jimenez-Rodriguez RM *et al*. Minimally invasive surgery in digestive emergencies

Rosa M Jimenez Rodriguez, Juan José Segura-Sampedro, Mercedes Flores-Cortés, Francisco López-Bernal, Cristobalina Martín, Verónica Pino Diaz, Felipe Pareja Ciuro, Javier Padillo Ruiz

**Rosa M Jimenez Rodriguez, Mercedes Flores-Cortés, Francisco López-Bernal, Cristobalina Martín, Verónica Pino Diaz, Felipe Pareja Ciuro, Javier Padillo Ruiz,** Colorectal Unit, Department of Surgery,Hospital Universitario Virgen del Rocío, 41013 Sevilla, Spain

**Juan José Segura-Sampedro,** Hospital Universitario Son Espases, 07010 Palma de Mallorca, Spain

**Author contributions:** All authors were responsible for conceptualizing and designing the study; collecting, analysing and interpreting the data and drafting the manuscript; all authors gave their approval on the final version for publication.

**Conflict-of-interest statement:** the authors have no conflict of interest related to the manuscript.

**Open-Access:** This article is an open-access article which was selected by an in-house editor and fully peer-reviewed by external reviewers. It is distributed in accordance with the Creative Commons Attribution Non Commercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited and the use is non-commercial. See: http://creativecommons.org/licenses/by-nc/4.0/

# Correspondence to: Rosa M Jimenez-Rodriguez, MD, PhD, EBSQ-c, Colorectal Unit, Department of Surgery, Hospital Universitario Virgen del Rocío, 41013 Sevilla, Spain. [ros\_j\_r@hotmail.com](mailto:ros_j_r@hotmail.com)

**Telephone:** +34-606-296081

**Fax:** +34-955-012313

**Received:** October 4, 2015

**Peer-review started:** October 5, 2015

**First decision:** November 27, 2015

**Revised:** December 24, 2015

**Accepted:** January 9, 2016

**Article in press:**

**Published online:**

# Abstract

This review focuses on the laparoscopic approach to gastrointestinal emergencies and its more recent indications. Laparoscopic surgery has a specific place in elective procedures, but that does not apply in emergency situations. In specific emergencies, there is a huge range of indications and different techniques to apply, and not all of them are equally settle. We consider that the most controversial points in minimally invasive procedures are indications in emergency situations due to technical difficulties. Some pathologies, such as oesophageal emergencies, obstruction due to colon cancer, abdominal hernias or incarcerated postsurgical hernias, are nearly always resolved by conventional surgery, that is, an open approach due to limited intraabdominal cavity space or due to the vulnerability of the bowel. These technical problems have been solved in many diseases, such as for perforated peptic ulcer or acute appendectomy for which a laparoscopic approach has become a well-known and globally supported procedure. On the other hand, endoscopic procedures have acquired further indications, relegating surgical solutions to a second place; this happens in cholangitis or pancreatic abscess drainage. This endoluminal approach avoids the need for laparoscopic development in these diseases. Nevertheless, new instruments and new technologies could extend the laparoscopic approach to a broader array of potentials procedures. There remains, however, a long way to go.

**Key words:** Minimally invasive surgery; Emergency surgery; Gastrointestinal surgery; Digestive emergencies; Abdominal emergencies

**© The Author(s) 2016.** Published by Baishideng Publishing Group Inc. All rights reserved.

**Core tip:** Laparoscopic surgery represents a technological revolution in the management of gastrointestinal conditions. However, the use of this minimally invasive technique has not yet been extended to emergency situations. The most likely reason is the long learning curve and the even longer operative time of emergency laparoscopy compared to elective laparoscopy.

Rodriguez RMJ, Segura-Sampedro JJ, Flores-Cortés M, López-Bernal F, Martín C, Diaz VP, Ciuro FP, Ruiz JP. Laparoscopic approach in gastrointestinal emergencies. *World J Gastroenterol* 2016; In press

## INTRODUCTION

Laparoscopic surgery offers multiple advantages for patients, including faster recovery and better cosmetic outcomes than conventional open surgery. Consequently, the laparoscopic approach is now widely used all over the world. However, the use of this minimally invasive technique is not as pervasive in emergency settings. The aim of the present study, therefore, is to determine the current status of laparoscopic surgery in gastrointestinal emergencies.

# Laparoscopic approach in upper gastrointestinal emergencies

Laparoscopic surgery in gastric and oesophageal life-threatening conditions has proved a feasible and safe technique, but several conditions must be considered.

## *Oesophageal perforation*

The most common cause of oesophageal perforation is iatrogenic, which is related to oesophageal instrumentation. Recent advances in endoscopic and minimally invasive techniques (endoluminal stents, endoscopic intraluminal clipping, use of various sealant substances, *etc*.) have resulted in lower rates of reoperation, open surgical interventions, oesophagostomies, morbidity and mortality, in comparison to conventional surgery[1,2].

According to Ben-David *et al*[3], a laparoscopic approach is feasible in the event of: (1) Uncontained leak into the chest: treatment may include oesophageal stent plus laparoscopic or thoracoscopic drainage and laparoscopic feeding jejunostomy; (2) Uncontained leak into the abdomen < 24 h: treatment may include minimally invasive repair, a gastric wrap and jejunostomy; and (3) Uncontained leak into the abdomen > 24 h: treatment may include a stent plus laparoscopic drainage and feeding jejunostomy.

Laparoscopic treatment for perforations secondary to pneumatic dilation for achalasia and Boerhaave syndrome have also been described in the literature[4-8].

In any case, only an expert in laparoscopic surgery can perform these techniques.

## *Perforated peptic ulcer*

The therapeutic goal in the treatment of perforated peptic ulcer is to repair the hole in the gastrointestinal tract and to treat any peritoneal contamination. Perforation is more common at the duodenal bulb (62%), followed by the pyloric region (20%) and the gastric body (18%)[9,10].

The feasibility and safety of laparoscopic closure of perforated ulcers has already been reported in several large series. There are numerous potential benefits associated with this minimally invasive technique. Laparoscopic simple patch closure of the perforation can be accomplished relatively easily and seems to be an effective treatment[11,12].

The three most common reasons for conversion are: large perforation size (often > 10 mm), inadequate ulcer localization and difficulties placing reliable sutures due to friable edges[13-17].

In the Cochrane review, we observed a tendency for laparoscopic repair to present with a lower incidence of septic intra-abdominal complications, surgical site infection, postoperative ileus, pulmonary complications and mortality than open surgery. The time of nasogastric aspiration and time to oral diet were reported in a non-parametric format, and the between-group differences were not statistically significant. With regard to cost and outcomes, there were no differences between laparoscopy and an open technique[18].

Nevertheless, the results of this systematic review must be interpreted carefully because of the small size of the examined samples.

In selected patients, the initial outcomes of laparoscopic repair of perforated peptic ulcers seem promising and allow for an early recovery. This is particularly important in the case of elderly and/or immunocompromised patients. Technical aspects and patient selection criteria continue to evolve in this respect[19-21].

A case report has described single-port laparoscopic repair as a feasible and safe procedure that may be a less invasive and scarless surgical treatment for perforated duodenal ulcers[22-24].

## Laparoscopic approach in hepatobiliary emergencies

## *Acute cholecystitis*

Acute cholecystitis (AC) is the leading cause of infection of the biliary tree, which affects 20%-30% of patients with biliary colic and is the third most common cause of acute abdomen in emergency departments.

The treatment of AC has varied in recent years. Although the laparoscopic approach has meant a revolution in the treatment of biliary diseases, it was not until the last decade of the 20th century that laparoscopic cholecystectomy became the treatment of choice for the management of gallbladder lesions as well as the treatment of choice for AC[25,26].

Decision-making regarding surgical timing has been a controversial subject[25-27]. Currently, early laparoscopic cholecystectomy (within the first 72 h) is considered to be a safe and effective procedure which reduces recovery time and hospital stays relative to deferred laparoscopic cholecystectomy[25,28].

The duration of disease evolution has been associated with a higher incidence of conversion. Therefore, most studies recommend that laparoscopic cholecystectomy be conducted within the first 24 h[25,27,29]. The indications for laparoscopic cholecystectomy after such a period, however, remain controversial. Several revision studies and meta-analyses have shown that laparoscopic surgery during the first week of disease evolution does not increase the incidence of complications or conversion in comparison to deferred surgery. However, sanitary costs are reduced and quality-adjusted life year is increased[25,30-32].

The updated Tokyo guidelines present new standards for the management of AC, such as the choice of treatment depending on severity grading[24] (Table 1).

***Acute cholangitis***

Acute cholangitis (ac) is caused by an obstruction of the biliary tree, which leads to an increase in intraductal pressure which eventually results in rapid bacteremia and sepsis. The obstruction can result from lithiasis, stenoses or the presence of tumoural cells[27]. ac has elevated mortality rates ranging from 11% to 27% and are usually associated with a delay in the diagnosis and initiation of appropriate treatment[33].

Most patients (70%) show a favourable initial response to medical treatment. When there is no response to medication, urgent endoscopic decompression of the bile ducts is indicated.

The recommended treatment for ac depends on the severity grading (Table 2).

***Choledocolithiasis***

There are many options for the treatment of choledocolithiasis, but few studies have provided convincing evidence for the superiority of one method over another[34].

An open approach is restricted to institutions where an endoscopic approach and minimally invasive surgery are unavailable or to certain patients whose previous open surgery limits the application of endoscopic techniques (*i.e.*, Roux-en-Y)[34].

Concomitant laparoscopic cholecystectomy with common bile duct exploration has been indicated by expert laparoscopic surgeons. However, the steep learning curve, necessity of a T-tube and the lack of advantages shown in recent studies have hindered the spread of this approach[34].

The most commonly accepted approach combines laparoscopic cholecystectomy with ERCP. No consensus currently exists on the timing of intervention, and different options are proposed in the literature. These include ERCP first followed by laparoscopic cholecystectomy, laparoscopic cholecystectomy first followed by ERCP and even a one-stage procedure combining ERCP with laparoscopic cholecystectomy. None of the options has proved superior to the others, so the timing of ERCP will depend on expertise and resources[34].

***Hepatic abscess***

Hepatic abscesses have a reported mortality of 6 to 14% depending on the series[34,35].

Initial management requires early initiation of intravenous antibiotic therapy. Percutaneous aspiration is the most common approach, having an 85%-95% success rate and low morbidity and mortality. Predictive factors for aspiration include age ≥ 55 years, an abscess size ≥ 5 cm, involvement of both lobes of the liver and a symptom duration ≥ 7 d[36]. Surgical drainage is indicated for abscesses of biliary origin, intraabdominal collections secondary to surgery or in cases where percutaneous aspiration is contraindicated or expected to fail due to the presence of multiloculated abscess, biliary communication, elevated urea, creatinine and total bilirubin levels[35,37]. In these cases, laparoscopic surgery may be an effective alternative to conventional open surgery, but further studies must be conducted to support this assumption.

**Laparoscopic approach in pancreatic emergencies**

***Pancreatitis and its complications***

Pancreatic disorders requiring an urgent surgical approach, with the exception of pancreatic trauma managed as abdominal trauma, are in practice limited to cases of acute pancreatitis, its aetiology and complications. Index admission laparoscopic cholecystectomy is indicated for patients with mild pancreatitis[38,39].

The Atlanta classification for acute pancreatitis describes two clinical forms of the disease: interstitial edematous pancreatitis and necrotizing pancreatitis. Through their progression, both forms may present with local complications, such as peripancreatic collections, pseudocysts, acute necrotic collections, organized pancreatic necrotic collections, infected necrotizing pancreatitis, gastroduodenal obstruction, portal vein thrombosis, colonic ischaemia, bleeding, pancreatic duct rupture or visceral artery pseudoaneurysm[40]. Approximately 20% of patients present with necrotizing pancreatitis, while 30% of them develop a secondary infection with a mortality rate of approximately 39%[41].

The management of acute pancreatitis is mainly medical. Patients with severe symptoms are monitored in Intensive Care Units and may require invasive surgery, especially in cases of complicated necrotizing pancreatitis[42]. The evidence-based guidelines for the management of acute pancreatitis published in 2013 by the International Association of Pancreatology and the American Pancreatic Association recommend intervention (radiological, endoscopic or surgical) in cases of necrotizing pancreatitis with clinical suspicion of, or documented evidence for, infected necrotizing pancreatitis with clinical deterioration, preferably when the necrosis is encapsulated (> 4 wk of onset of symptoms). In the absence of documented infected necrotizing pancreatitis, these interventions are recommended in cases of ongoing organ failure, preferably when the necrosis is encapsulated or leads to gastrointestinal obstruction (4-8 wk after onset of symptoms). The best recommended approach is percutaneous retroperitoneal catheter or endoscopic transluminal drainage followed, if necessary, by endoscopic or surgical necrosectomy[38].

For years, open necrosectomy has been the mainstay treatment option for acute pancreatitis. However, this approach has been associated with high mortality rates (11%-39%) and an elevated incidence of complications (34%-95%). Therefore, in recent years, minimally invasive techniques have increasingly been chosen, such as percutaneous drainage, endoscopic transluminal drainage and minimally invasive necrosectomy[43].

The step-up approach, which consists of initial percutaneous or endoscopic drainage and continues with minimally invasive necrosectomy, if necessary, has bene shown to reduce morbidity, mortality and complications when compared with open necrosectomy[44-46].

Two minimally invasive techniques have become generally accepted as treatment options: minimal access retroperitoneal pancreatic necrosectomy (MARPN)[9] and video-assisted retroperitoneal debridement (VARD)[47].

VARD consists of drainage and debridement by means of a subcostal incision of 5 cm made in the left flank. A videoscope is then introduced into the incision using a single extra-long laparoscopic port. The cavity is inflated with CO2 gas to facilitate laparoscopic work and videoscopic inspection. VARD is described as fairly easy to implement, and the technique can be used in most cases of infected necrotizing pancreatitis[48]. Several prospective studies of this technique have reported positive morbidity and mortality outcomes. However, VARD has not been directly compared with open necrosectomy; rather, it is only a part of the step-up approach[49]. A shortcoming of this technique is that it may require several repeated procedures to completely remove the necrotic tissue. In addition, serious complications are possible, such as retroperitoneal bleeding[50].

Different laparoscopic debridement and necrosectomy techniques have been described for the management of acute pancreatitis as follows:

***Laparoscopic cystogastrostomy***

This procedure consists of debridement and drainage of necrotic tissue, creating a fistula between the cystic cavity and the stomach using laparoscopic techniques. Laparoscopic cystogastrostomy may be endoluminal, intragastric or transgastric. In the endoluminal approach, 2-3 trocars are inserted into the abdominal and gastric walls. A balloon is then inserted into the stomach, inflated and secured against the abdominal wall. Cystogastrostomy is then performed using the ultrasonic dissector or electrocautery. The intragastric procedure is performed to open the anterior abdominal wall to expose the gastric wall in close contact with the necrotic cavity. The cystogastrostomy is first secured using endoscopic staplers, followed by drainage of the necrotic tissue from the cavity. Recent studies have claimed that these techniques reduce morbidity and mortality rates associated with open necrosectomy and consider them safe and effective techniques in selected patients[51,52]. Moreover, these techniques allow for the management of larger and more solid collections in a one-step intervention while also making it possible to treat cholelithiasis in the same procedure[43].

***Laparoscopic transperitoneal necrosectomy***

The laparoscopic transperitoneal approach *via* different pathways (transgastrocolic, transmesocolic and infracolic) has been described for the treatment of acute necrotizing pancreatitis[53,54]. Parehk described a hand-assisted laparoscopic surgical approach for the treatment of pancreatic necrosis. Utilizing three ports, he reaches the lesser sac *via* an infracolic approach or through the greater omentum between the stomach and the colon. All the necrotic areas are carefully debrided, and once this step is completed, drains are placed in the lesser sac for drainage[55].

The advantage of these approaches is that they enable access to the lesser sac and ease the use of additional techniques such as cholecystectomy. However, we must consider such drawbacks as the necessity of pneumoperitoneum in critically-ill patients, the risk of infection dissemination through the peritoneal cavity and the risk of injuries during the intervention[56].

***Retroperitoneal laparoscopic debridement***

Tu *et al*[57] described retroperitoneal laparoscopic debridement and drainage of infected necrosis in severe acute pancreatitis via both flanks, depending on the localization of the necrosis and/or collections. Once a saline injection is used to expand the retroperitoneal space, four ports are inserted and CO2 retropneumoperitoneum is created. Once the necrotic tissue is debrided, two or three drains are left inside the cavity. The authors have published a series of 18 patients who underwent this technique and compared the outcomes with another series of 32 patients who had laparoscopic necrosectomy. The authors concluded that retroperitoneal laparoscopic debridement is a feasible, safe and effective technique for the treatment of infected necrosis.

It is possible to conclude that the step-up approach, consisting of drainage followed, if necessary, by minimally invasive techniques shows lower morbidity and mortality rates than open surgery, and as such, should be the only surgical approach considered.

However, no first-rate evidence exists to favour one minimally invasive technique over another.

**Laparoscopic approach in small-bowel emergencies**

***Acute small-bowel obstruction***

Small-bowel obstruction (SBO) is a common surgical emergency frequently caused by postoperative adhesions. In a large number of cases, adhesive SBO resolves with nonoperative treatment, but an important group of patients requires emergency surgery. For decades, open surgery has been the gold standard in treating adhesive SBO. Currently, laparoscopy has been adopted as a first-line option in many elective indications, and it is also emerging as a feasible alternative to treat this condition[58-61].

Open surgery remains the first option for the surgical treatment of strangulated ASBO after failed conservative treatment. Nevertheless, in selected groups of patients, laparoscopy can be a safe and effective approach using an open access technique through the left upper quadrant[58,59].

Laparoscopic adhesiolysis should preferably be attempted in patients with a first episode of ASBO and/or a single adhesive band. A low threshold for open conversion should be maintained, as we may expect complications associated with the use of this technique[59]. In fact, age and a prior history of laparotomy seem to be predictive factors of the occurrence of inadvertent enterotomy[60]. No statistically significant differences have been observed between open and laparoscopic adhesiolysis with regard to the incidence of intraoperative bowel injuries, wound infections and overall mortality[61].

Li *et al*[61] reported statistically significant differences between a laparoscopic and open surgery group, with fewer overall complications (OR = 0.42, 0.25-0.70, *p* < 0.01), as well as a lower incidence of prolonged ileus (OR = 0.28, 0.10-0.73, *p* = 0.01) in the laparoscopic group. According to the authors, the laparoscopic approach is safer than the open procedure, provided that it is carried out by experienced surgeons and in selected patients.

Moreover, laparoscopy in animal models has shown a lower incidence, extent and severity of intra-abdominal adhesions when compared with open surgery, and it may reduce the recurrence of adhesive small bowel obstruction[62]. Laparoscopy seems to offer an advantage over laparotomy in terms of the formation of adhesions in the abdominal wall and in the operative site[63,64].

Laparoscopic adhesiolysis for small bowel obstruction has a number of potential advantages[65,66], such as improved visualization of the entire abdominal cavity, diagnostic laparoscopy, less postoperative pain, earlier recovery of gastrointestinal function, shorter hospital stay, a faster recovery time, earlier return to full activity, decreased wound complications and lower incidence of postoperative adhesion formation.

Other less common causes of ASBO have been reported, such as intussusception[67], GISTs[68] and bezoars. Laparoscopy has been used to treat all of them with favourable outcomes. However, only case reports are available, and further studies are necessary to provide greater evidence and adequate recommendations.

In the case of small bowel obstruction due to incarcerated inguinal hernia,laparoscopic surgery, including TEP or TAPP repair, may be used to treat incarcerated or strangulated inguinal hernias[58].

While no known studies have examined laparoscopy with open surgery in adult patients undergoing emergency hernia repair, Watson[69] demonstrated that laparoscopic hernia repair (LHR) is a feasible option for the treatment of incarcerated hernias.

Deeba *et al*[70], in their review of the literature on this subject, found 328 cases reported, including 6 conversions, 34 complications (25 of which were considered minor), and 17 bowel resections, performed either laparoscopically or through a mini-laparotomy incision guided by laparoscopy. They concluded that the laparoscopic approach, either TEP or TAPP, is a feasible procedure for repairing incarcerated hernias, providing adequate anatomical knowledge and expertise to dissect and reduce the sac with favourable outcomes. However, further studies should be conducted, with a particular emphasis on larger multicentre randomized controlled trials.

***Incarcerated ventral hernias***

In 2010, an Italian Consensus Conference attended by the main National Scientific Societies underlined that the incidences of intra- and postoperative complications and recurrences in emergency surgery were the same as in elective cases[58]. Therefore, the laparoscopic approach to incarcerated ventral hernias might be performed in patients, according to a series of selection criteria (Table 3).

With regard to the operative procedure, the use of atraumatic graspers is essential, adhesiolysis should be proper and careful, and the contents of the defect should always be thoroughly tested for blood supply, motility and integrity. In the event of an enterotomy, the defect can be repaired by means of laparoscopy[58].

***Meckel's diverticulum***

The treatment of symptomatic Meckel's diverticulum is resection. Although more than 75% of resections are still open procedures[71], laparoscopic diverticulectomy is as safe and effective an approach as open surgery[72], and it can reduce the time to oral intake and patient discharge[73,74]. The lack of sensory feedback can be overcome using a trans-umbilical approach, which offers the cosmetic and postoperative advantages of laparoscopy but also allows surgeons to touch the specimen and confirm entire resection and the absence of masses[75,76].

***Acute mesenteric ischaemia***

There are no reports in the literature underlining any benefits or advantages of laparoscopy in the diagnosis or treatment of acute mesenteric ischaemia relative to classic imaging techniques[58]. However, laparoscopy may have a role as a "second-look procedure" in patients who have already had surgery for acute mesenteric ischaemia, as it allows for minimally invasive exploration[58,75].

**Laparoscopic approach in colorectal emergencies**

Since the first laparoscopic colectomy was described in 1991, its use has been extended from the treatment of benign and inflammatory disease to the treatment of colorectal cancer. Laparoscopic colectomy offers the same advantages of other laparoscopic procedures: shorter hospital stay, less postoperative pain and earlier return to full activity[77-79].

Whereas elective colorectal laparoscopic surgery is a well-established procedure, the use of this technique in emergency colorectal settings remains unclear[80,81]. At present , emergency colorectal laparoscopy is frequently used to treat acute appendicitis or else as a diagnostic technique to identify the origin of abdominal pain, especially in the right iliac fossa. The reason to avoid the use of laparoscopy for the treatment of emergency colorectal disease is the complexity of the condition which distorts the normal anatomy due to inflammation or tissue infection. Likewise, colon distension has traditionally posed a contraindication for laparoscopy preventing the use of this approach in colorectal emergencies[80,81].

Acute appendicitis

Acute appendicitis is probably the colorectal disease most frequently managed by means of laparoscopy in emergency settings.

The duration of surgery is greater in laparoscopic appendectomy but it shows less complications, earlier return to normal activity and greater patient's satisfaction[82,83]. In pediatric patients, the laparoscopic approach is associated with shorter hospital stay and a lower incidence of postoperative complications, especially in the case of perforated appendicitis[82,83]. Southgate *et al*[84] confirm the same outcomes in adult patients (> 60 years) and observe lower postoperative morbidity and mortality rates and shorter hospital stay.

With the growing adoption and standardization of laparoscopic technique, minimally invasive approaches have also been developed, such as the use of procedures leaving less scars, single-port appendectomy and transgastric appendectomy. All of them are feasible techniques which have not been equally accepted by all surgeons[85,86] due to the greater technical complexity or the higher costs; the latter being also reported of laparoscopic appendectomy in comparison with conventional open technique[87].

***Inflammatory bowel disease***

Patients with inflammatory bowel disease have a higher risk of requiring surgery at some point of their lives. The laparoscopic approach for the treatment of this condition has increased in recent years. In case of complications associated with bowel obstruction and free perforations into the peritoneal cavity, a minimally invasive approach has demonstrated shorter hospital stays but longer operative time[88-91].

Nash *et al*[88] have compared 22 patients with ulcerative colitis requiring emergency surgery and have divided them into two groups: open and laparoscopic approach. They described a longer operative time in the laparoscopic group. Watanabe et al. described also a shorter recovery period for patients undergoing minimally invasive surgery[88,89].

Nevertheless, in the absence of prospective comparative studies, authors like Qazi *et al*[90] and Bell *et al*[91] have also confirmed an increase of postoperative comorbidities, which may be the result of the immunosuppression provoked by the administration of immunosuppressants and/ or corticoids.

***Acute diverticulitis***

The laparoscopic approach for the treatment of acute diverticulitis has proved to be a feasible and safe technique with variable complication rates that may range from 0% to 54%. The use of this technique depends on the severity of diverticulitis. Most reports have described its effectiveness in the treatment of Hinchey stage III diverticulitis (purulent peritonitis without colonic perforation). The rate of stoma formation in these cases is very low as most patients underwent lavage and drainage of abdominal cavity without colonic resection. In these patients, laparoscopic colectomy shows a higher incidence of complications than laparoscopic peritoneal lavage. Moreover, ageing patients, immunosuppressed patients or those with systemic comorbidities have a higher risk of reintervention after laparoscopic lavage.

Some authors have described the use of laparoscopic surgery for the treatment of diverticulitis and have reported promising outcomes with low complication rates, no deaths and GI recovery rates reaching 90%. Conversion rate was minimal and operative time was not longer than in elective sigmoidectomy. Nevertheless, most patients included in the study presented with Hinchey stage I or II diverticulitis[92-94].

***Colorectal cancer emergencies***

Despite the lower mortality rates associated with elective laparoscopy for colorectal cancer, emergency laparoscopic surgery still shows elevated perioperative mortality rates due to patients characteristics and the technical difficulties provoked by the dilation and vulnerability of intestinal loops in emergency settings[95].

With the introduction of endoluminal stents, laparoscopy became a feasible approach in left-sided colonic cancer by means of the so-called deferred surgery. However, several studies aiming at demonstrating the usefulness of stenting as a bridge to surgery were cancelled due to the negative outcomes[96,97].

Odermatt *et al*[98] in a prospective observational study showed that emergency laparoscopic colonic resection is a safe and feasible procedure with short- and long-term outcomes very similar to those obtained by means of open surgery and with lower hospital stays. Most of the patients included in the study presented with right-sided colonic cancer and only 8% required conversion to open surgery, which suggests that many of the patients who underwent open surgery might have been managed by means of laparoscopy. However, although these authors report the resection of stage 4 tumors by means of laparoscopy, they confirm the complexity of the procedure in these settings and defend the use of palpation for accurate tumor assessment[98].

**CONCLUSION**

Although laparoscopic surgery has been adopted as a gold standard in the treatment of gastrointestinal diseases by means of such approaches as cholecystectomy or colectomy, its presence in emergency settings has to be reaffirmed.

**REFERENCES**

1 **Orringer MB**, Stirling MC. Esophagectomy for esophageal disruption. *Ann Thorac Surg* 1990; **49**: 35-42; discussion 42-3 [PMID: 2297275]

2 **Sung SW**, Park JJ, Kim YT, Kim JH. Surgery in thoracic esophageal perforation: primary repair is feasible. *Dis Esophagus* 2002; **15**: 204-209 [PMID: 12444991]

3 **Ben-David K**, Behrns K, Hochwald S, Rossidis G, Caban A, Crippen C, Caranasos T, Hughes S, Draganov P, Forsmark C, Chauhan S, Wagh MS, Sarosi G. Esophageal perforation management using a multidisciplinary minimally invasive treatment algorithm. *J Am Coll Surg* 2014; **218**: 768-774 [PMID: 24529810 DOI: 10.1016/j.jamcollsurg.2013.12.033]

4 **Sánchez-Pernaute A**, Aguirre EP, Talavera P, Valladares LD, de la Serna JP, Mantilla CS, de León AR, Torres A. Laparoscopic approach to esophageal perforation secondary to pneumatic dilation for achalasia. *Surg Endosc* 2009; **23**: 1106-1109 [PMID: 18814004 DOI: 10.1007/s00464-008-0114-7]

5 **Kimberley KL**, Ganesh R, Anton CK. Laparoscopic repair of esophageal perforation due to Boerhaave syndrome. *Surg Laparosc Endosc Percutan Tech* 2011; **21**: e203-e205 [PMID: 21857462 DOI: 10.1097/SLE.0b013e3182245771]

6 **Toelen C**, Hendrickx L, Van Hee R. Laparoscopic treatment of Boerhaave's syndrome: a case report and review of the literature. *Acta Chir Belg* 2007; **107**: 402-404 [PMID: 17966533]

7 **Landen S**, El Nakadi I. Minimally invasive approach to Boerhaave's syndrome: a pilot study of three cases. *Surg Endosc* 2002; **16**: 1354-1357 [PMID: 12023725]

8 **Hunt DR**, Wills VL, Weis B, Jorgensen JO, DeCarle DJ, Coo IJ. Management of esophageal perforation after pneumatic dilation for achalasia. *J Gastrointest Surg* 2000; **4**: 411-415 [PMID: 11058860]

9 **Wang YR**, Richter JE, Dempsey DT. Trends and outcomes of hospitalizations for peptic ulcer disease in the United States, 1993 to 2006. *Ann Surg* 2010; **251**: 51-58 [PMID: 20009753 DOI: 10.1097/SLA.0b013e3181b975b8]

10 **Bertleff MJ**, Lange JF. Laparoscopic correction of perforated peptic ulcer: first choice? A review of literature. *Surg Endosc* 2010; **24**: 1231-1239 [PMID: 20033725 DOI: 10.1007/s00464-009-0765-z]

11 **Kaiser AM**, Katkhouda N. Laparoscopic management of the perforated viscus. *Semin Laparosc Surg* 2002; **9**: 46-53 [PMID: 11979410]

12 **Byrge N**, Barton RG, Enniss TM, Nirula R. Laparoscopic versus open repair of perforated gastroduodenal ulcer: a National Surgical Quality Improvement Program analysis. *Am J Surg* 2013; **206**: 957-62; discussion 962-3 [PMID: 24112676 DOI: 10.1016/j.amjsurg.2013.08.014]

13 **Bertleff M**, Lange J. Reply to: doi: 10.1007/s00464-009-0765-z: Laparoscopic correction of perforated peptic ulcer: first choice? A review of literature. *Surg Endosc* 2012; **26**: 288 [PMID: 21898026 DOI: 10.1007/s00464-009-0765-z: ]

14 **Bertleff MJ**, Halm JA, Bemelman WA, van der Ham AC, van der Harst E, Oei HI, Smulders JF, Steyerberg EW, Lange JF. Randomized clinical trial of laparoscopic versus open repair of the perforated peptic ulcer: the LAMA Trial. *World J Surg* 2009; **33**: 1368-1373 [PMID: 19430829 DOI: 10.1007/s00268-009-0054-y]

15 **Siu WT**, Leong HT, Law BK, Chau CH, Li AC, Fung KH, Tai YP, Li MK. Laparoscopic repair for perforated peptic ulcer: a randomized controlled trial. *Ann Surg* 2002; **235**: 313-319 [PMID: 11882751]

16 **Lau WY**, Leung KL, Kwong KH, Davey IC, Robertson C, Dawson JJ, Chung SC, Li AK. A randomized study comparing laparoscopic versus open repair of perforated peptic ulcer using suture or sutureless technique. *Ann Surg* 1996; **224**: 131-138 [PMID: 8757375]

17 **Kim JH**, Chin HM, Bae YJ, Jun KH. Risk factors associated with conversion of laparoscopic simple closure in perforated duodenal ulcer. *Int J Surg* 2015; **15**: 40-44 [PMID: 25644542 DOI: 10.1016/j.ijsu.2015.01.028]

18 **Wright GP**, Davis AT, Koehler TJ, Scheeres DE. Cost-efficiency and outcomes in the treatment of perforated peptic ulcer disease: laparoscopic versus open approach. *Surgery* 2014; **156**: 1003-1007 [PMID: 25239359 DOI: 10.1016/j.surg.2014.06.047]

19 **Bingener J**, Loomis EA, Gostout CJ, Zielinski MD, Buttar NS, Song LM, Baron TH, Ghahfarokhi LS, Rajan E. Feasibility of NOTES omental plug repair of perforated peptic ulcers: results from a clinical pilot trial. *Surg Endosc* 2013; **27**: 2201-2208 [PMID: 23355151 DOI: 10.1007/s00464-012-2740-3]

20 **Bonin EA**, Moran E, Gostout CJ, McConico AL, Zielinski M, Bingener J. Natural orifice transluminal endoscopic surgery for patients with perforated peptic ulcer. *Surg Endosc* 2012; **26**: 1534-1538 [PMID: 22179453 DOI: 10.1007/s00464-011-2063-9]

21 **Moran EA**, Gostout CJ, McConico AL, Michalek J, Huebner M, Bingener J. Assessing the invasiveness of NOTES perforated viscus repair: a comparative study of NOTES and laparoscopy. *Surg Endosc* 2012; **26**: 103-109 [PMID: 21792716 DOI: 10.1007/s00464-011-1834-7]

22 **Lee J**, Sung K, Lee D, Lee W, Kim W. Single-port laparoscopic repair of a perforated duodenal ulcer: intracorporeal "cross and twine" knotting. *Surg Endosc* 2011; **25**: 229-233 [PMID: 20549241 DOI: 10.1007/s00464-010-1164-1]

23 **Mazeh H**, Mizrahi I, Dior U, Simanovsky N, Shapiro M, Freund HR, Eid A. Role of antibiotic therapy in mild acute calculus cholecystitis: a prospective randomized controlled trial. *World J Surg* 2012; **36**: 1750-1759 [PMID: 22456803 DOI: 10.1007/s00268-012-1572-6]

24 **Yokoe M**, Takada T, Strasberg SM, Solomkin JS, Mayumi T, Gomi H, Pitt HA, Garden OJ, Kiriyama S, Hata J, Gabata T, Yoshida M, Miura F, Okamoto K, Tsuyuguchi T, Itoi T, Yamashita Y, Dervenis C, Chan AC, Lau WY, Supe AN, Belli G, Hilvano SC, Liau KH, Kim MH, Kim SW, Ker CG. TG13 diagnostic criteria and severity grading of acute cholecystitis (with videos). *J Hepatobiliary Pancreat Sci* 2013; **20**: 35-46 [PMID: 23340953 DOI: 10.1007/s00534-012-0568-9]

25 **Sartelli M**, Viale P, Catena F, Ansaloni L, Moore E, Malangoni M, Moore FA, Velmahos G, Coimbra R, Ivatury R, Peitzman A, Koike K, Leppaniemi A, Biffl W, Burlew CC, Balogh ZJ, Boffard K, Bendinelli C, Gupta S, Kluger Y, Agresta F, Di Saverio S, Wani I, Escalona A, Ordonez C, Fraga GP, Junior GA, Bala M, Cui Y, Marwah S, Sakakushev B, Kong V, Naidoo N, Ahmed A, Abbas A, Guercioni G, Vettoretto N, Díaz-Nieto R, Gerych I, Tranà C, Faro MP, Yuan KC, Kok KY, Mefire AC, Lee JG, Hong SK, Ghnnam W, Siribumrungwong B, Sato N, Murata K, Irahara T, Coccolini F, Segovia Lohse HA, Verni A, Shoko T. 2013 WSES guidelines for management of intra-abdominal infections. *World J Emerg Surg* 2013; **8**: 3 [PMID: 23294512 DOI: 10.1186/1749-7922-8-3]

26 **Knab LM**, Boller AM, Mahvi DM. Cholecystitis. *Surg Clin North Am* 2014; **94**: 455-470 [PMID: 24679431 DOI: 10.1016/j.suc.2014.01.005]

27 **Fagenholz PJ**, de Moya MA. Acute inflammatory surgical disease. *Surg Clin North Am* 2014; **94**: 1-30 [PMID: 24267493 DOI: 10.1016/j.suc.2013.10.008]

28 **Miura F**, Takada T, Strasberg SM, Solomkin JS, Pitt HA, Gouma DJ, Garden OJ, Büchler MW, Yoshida M, Mayumi T, Okamoto K, Gomi H, Kusachi S, Kiriyama S, Yokoe M, Kimura Y, Higuchi R, Yamashita Y, Windsor JA, Tsuyuguchi T, Gabata T, Itoi T, Hata J, Liau KH; Tokyo Guidelines Revision Committee. TG13 flowchart for the management of acute cholangitis and cholecystitis. *J Hepatobiliary Pancreat Sci* 2013; **20**: 47-54 [PMID: 23307003 DOI: 10.1007/s00534-012-0563-1]

29 **Gurusamy KS**, Davidson C, Gluud C, Davidson BR. Early versus delayed laparoscopic cholecystectomy for people with acute cholecystitis. *Cochrane Database Syst Rev* 2013; **6**: CD005440 [PMID: 23813477 DOI: 10.1002/14651858.CD005440.pub3]

30 **Banz V**, Gsponer T, Candinas D, Güller U. Population-based analysis of 4113 patients with acute cholecystitis: defining the optimal time-point for laparoscopic cholecystectomy. *Ann Surg* 2011; **254**: 964-970 [PMID: 21817893 DOI: 10.1097/SLA.0b013e318228d31c]

31 **Navez B**, Ungureanu F, Michiels M, Claeys D, Muysoms F, Hubert C, Vanderveken M, Detry O, Detroz B, Closset J, Devos B, Kint M, Navez J, Zech F, Gigot JF. Surgical management of acute cholecystitis: results of a 2-year prospective multicenter survey in Belgium. *Surg Endosc* 2012; **26**: 2436-2445 [PMID: 22407152]

32 **Wilson E**, Gurusamy K, Gluud C, Davidson BR. Cost-utility and value-of-information analysis of early versus delayed laparoscopic cholecystectomy for acute cholecystitis. *Br J Surg* 2010; **97**: 210-219 [PMID: 20035545 DOI: 10.1002/bjs.6872]

33 **Shirah GR**, O'Neill PJ. Intra-abdominal Infections. *Surg Clin North Am* 2014; **94**: 1319-1333 [PMID: 25440126 DOI: 10.1016/j.suc.2014.08.005]

34 **Bencini L**, Tommasi C, Manetti R, Farsi M. Modern approach to cholecysto-choledocholithiasis. *World J Gastrointest Endosc* 2014; **6**: 32-40 [PMID: 24567790 DOI: 10.4253/wjge.v6.i2.32]

35 **Tan L**, Zhou HJ, Hartman M, Ganpathi IS, Madhavan K, Chang S. Laparoscopic drainage of cryptogenic liver abscess. *Surg Endosc* 2013; **27**: 3308-3314 [PMID: 23494514 DOI: 10.1007/s00464-013-2910-y]

36 **Khan R**, Hamid S, Abid S, Jafri W, Abbas Z, Islam M, Shah H, Beg S. Predictive factors for early aspiration in liver abscess. *World J Gastroenterol* 2008; **14**: 2089-2093 [PMID: 18395912 DOI: 10.3748/wjg.14.2089]

37 **Mezhir JJ**, Fong Y, Jacks LM, Getrajdman GI, Brody LA, Covey AM, Thornton RH, Jarnagin WR, Solomon SB, Brown KT. Current management of pyogenic liver abscess: surgery is now second-line treatment. *J Am Coll Surg* 2010; **210**: 975-983 [PMID: 20510807 DOI: 10.1016/j.jamcollsurg.2010.03.004]

38 **Working Group IAP/APA Acute Pancreatitis Guidelines**. IAP/APA evidence-based guidelines for the management of acute pancreatitis. *Pancreatology* 2013; **13**: e1-15 [PMID: 24054878 DOI: 10.1016/j.pan.2013.07.063]

39 **Yadav D**, Lowenfels AB. The epidemiology of pancreatitis and pancreatic cancer. *Gastroenterology* 2013; **144**: 1252-1261 [PMID: 23622135 DOI: 10.1053/j.gastro.2013.01.068]

40 **Banks PA**, Bollen TL, Dervenis C, Gooszen HG, Johnson CD, Sarr MG, Tsiotos GG, Vege SS. Classification of acute pancreatitis--2012: revision of the Atlanta classification and definitions by international consensus. *Gut* 2013; **62**: 102-111 [PMID: 23100216 DOI: 10.1136/gutjnl-2012-302779]

41 **Chang YC**. Is necrosectomy obsolete for infected necrotizing pancreatitis? Is a paradigm shift needed? *World J Gastroenterol* 2014; **20**: 16925-16934 [PMID: 25493005 DOI: 10.3748/wjg.v20.i45.16925]

42 **Babu RY**, Gupta R, Kang M, Bhasin DK, Rana SS, Singh R. Predictors of surgery in patients with severe acute pancreatitis managed by the step-up approach. *Ann Surg* 2013; **257**: 737-750 [PMID: 22968079 DOI: 10.1097/SLA.0b013e318269d25d]

43 **Karakayali FY**. Surgical and interventional management of complications caused by acute pancreatitis. *World J Gastroenterol* 2014; **20**: 13412-13423 [PMID: 25309073 DOI: 10.3748/wjg.v20.i37.13412]

44 **van Santvoort HC**, Besselink MG, Bakker OJ, Hofker HS, Boermeester MA, Dejong CH, van Goor H, Schaapherder AF, van Eijck CH, Bollen TL, van Ramshorst B, Nieuwenhuijs VB, Timmer R, Laméris JS, Kruyt PM, Manusama ER, van der Harst E, van der Schelling GP, Karsten T, Hesselink EJ, van Laarhoven CJ, Rosman C, Bosscha K, de Wit RJ, Houdijk AP, van Leeuwen MS, Buskens E, Gooszen HG. A step-up approach or open necrosectomy for necrotizing pancreatitis. *N Engl J Med* 2010; **362**: 1491-1502 [PMID: 20410514 DOI: 10.1056/NEJMoa0908821]

45 **Horvath K**, Freeny P, Escallon J, Heagerty P, Comstock B, Glickerman DJ, Bulger E, Sinanan M, Langdale L, Kolokythas O, Andrews RT. Safety and efficacy of video-assisted retroperitoneal debridement for infected pancreatic collections: a multicenter, prospective, single-arm phase 2 study. *Arch Surg* 2010; **145**: 817-825 [PMID: 20855750 DOI: 10.1001/archsurg.2010.178]

46 **Raraty MG**, Halloran CM, Dodd S, Ghaneh P, Connor S, Evans J, Sutton R, Neoptolemos JP. Minimal access retroperitoneal pancreatic necrosectomy: improvement in morbidity and mortality with a less invasive approach. *Ann Surg* 2010; **251**: 787-793 [PMID: 20395850 DOI: 10.1097/SLA.0b013e3181d96c53]

47 **da Costa DW**, Boerma D, van Santvoort HC, Horvath KD, Werner J, Carter CR, Bollen TL, Gooszen HG, Besselink MG, Bakker OJ. Staged multidisciplinary step-up management for necrotizing pancreatitis. *Br J Surg* 2014; **101**: e65-e79 [PMID: 24272964 DOI: 10.1002/bjs.9346]

48 **van Santvoort HC**, Besselink MG, Horvath KD, Sinanan MN, Bollen TL, van Ramshorst B, Gooszen HG. Videoscopic assisted retroperitoneal debridement in infected necrotizing pancreatitis. *HPB (Oxford)* 2007; **9**: 156-159 [PMID: 18333133 DOI: 10.1080/13651820701225688]

49 **Bello B**, Matthews JB. Minimally invasive treatment of pancreatic necrosis. *World J Gastroenterol* 2012; **18**: 6829-6835 [PMID: 23239921 DOI: 10.3748/wjg.v18.i46.6829]

50 **Zerem E**. Treatment of severe acute pancreatitis and its complications. *World J Gastroenterol* 2014; **20**: 13879-13892 [PMID: 25320523 DOI: 10.3748/wjg.v20.i38.13879]

51 **Gibson SC**, Robertson BF, Dickson EJ, McKay CJ, Carter CR. 'Step-port' laparoscopic cystgastrostomy for the management of organized solid predominant post-acute fluid collections after severe acute pancreatitis. *HPB (Oxford)* 2014; **16**: 170-176 [PMID: 23551864 DOI: 10.1111/hpb.12099]

52 **Worhunsky DJ**, Qadan M, Dua MM, Park WG, Poultsides GA, Norton JA, Visser BC. Laparoscopic transgastric necrosectomy for the management of pancreatic necrosis. *J Am Coll Surg* 2014; **219**: 735-743 [PMID: 25158913 DOI: 10.1016/j.jamcollsurg.2014.04.012]

53 **Mathew MJ**, Parmar AK, Sahu D, Reddy PK. Laparoscopic necrosectomy in acute necrotizing pancreatitis: Our experience. *J Minim Access Surg* 2014; **10**: 126-131 [PMID: 25013328 DOI: 10.4103/0972-9941.134875]

54 **Wani SV**, Patankar RV, Mathur SK. Minimally invasive approach to pancreatic necrosectomy. *J Laparoendosc Adv Surg Tech A* 2011; **21**: 131-136 [PMID: 21284517 DOI: 10.1089/lap.2010.0401]

55 **Parekh D**. Laparoscopic-assisted pancreatic necrosectomy: A new surgical option for treatment of severe necrotizing pancreatitis. *Arch Surg* 2006; **141**: 895-902; discussion 902-3 [PMID: 16983033]

56 **Navaneethan U**, Vege SS, Chari ST, Baron TH. Minimally invasive techniques in pancreatic necrosis. *Pancreas* 2009; **38**: 867-875 [PMID: 19855233 DOI: 10.1097/MPA.0b013e3181b3b237]

57 **Tu Y**, Jiao H, Tan X, Sun L, Zhang W. Laparotomy versus retroperitoneal laparoscopy in debridement and drainage of retroperitoneal infected necrosis in severe acute pancreatitis. *Surg Endosc* 2013; **27**: 4217-4223 [PMID: 23793802 DOI: 10.1007/s00464-013-3026-0]

58 **Agresta F**, Ansaloni L, Baiocchi GL, Bergamini C, Campanile FC, Carlucci M, Cocorullo G, Corradi A, Franzato B, Lupo M, Mandalà V, Mirabella A, Pernazza G, Piccoli M, Staudacher C, Vettoretto N, Zago M, Lettieri E, Levati A, Pietrini D, Scaglione M, De Masi S, De Placido G, Francucci M, Rasi M, Fingerhut A, Uranüs S, Garattini S. Laparoscopic approach to acute abdomen from the Consensus Development Conference of the Società Italiana di Chirurgia Endoscopica e nuove tecnologie (SICE), Associazione Chirurghi Ospedalieri Italiani (ACOI), Società Italiana di Chirurgia (SIC), Società Italiana di Chirurgia d'Urgenza e del Trauma (SICUT), Società Italiana di Chirurgia nell'Ospedalità Privata (SICOP), and the European Association for Endoscopic Surgery (EAES). *Surg Endosc* 2012; **26**: 2134-2164 [PMID: 22736283 DOI: 10.1007/s00464-012-2331-3]

59 **Di Saverio S**, Coccolini F, Galati M, Smerieri N, Biffl WL, Ansaloni L, Tugnoli G, Velmahos GC, Sartelli M, Bendinelli C, Fraga GP, Kelly MD, Moore FA, Mandalà V, Mandalà S, Masetti M, Jovine E, Pinna AD, Peitzman AB, Leppaniemi A, Sugarbaker PH, Goor HV, Moore EE, Jeekel J, Catena F. Bologna guidelines for diagnosis and management of adhesive small bowel obstruction (ASBO): 2013 update of the evidence-based guidelines from the world society of emergency surgery ASBO working group. *World J Emerg Surg* 2013; **8**: 42 [PMID: 24112637 DOI: 10.1186/1749-7922-8-42]

60 **Van Der Krabben AA**, Dijkstra FR, Nieuwenhuijzen M, Reijnen MM, Schaapveld M, Van Goor H. Morbidity and mortality of inadvertent enterotomy during adhesiotomy. *Br J Surg* 2000; **87**: 467-471 [PMID: 10759744]

61 **Li MZ**, Lian L, Xiao LB, Wu WH, He YL, Song XM. Laparoscopic versus open adhesiolysis in patients with adhesive small bowel obstruction: a systematic review and meta-analysis. *Am J Surg* 2012; **204**: 779-786 [PMID: 22794708 DOI: 10.1016/j.amjsurg.2012.03.005]

62 **Tittel A**, Treutner KH, Titkova S, Ottinger A, Schumpelick V. Comparison of adhesion reformation after laparoscopic and conventional adhesiolysis in an animal model. *Langenbecks Arch Surg* 2001; **386**: 141-145 [PMID: 11374047]

63 **Gadallah MF**, Torres-Rivera C, Ramdeen G, Myrick S, Habashi S, Andrews G. Relationship between intraperitoneal bleeding, adhesions, and peritoneal dialysis catheter failure: a method of prevention. *Adv Perit Dial* 2001; **17**: 127-129 [PMID: 11510259]

64 **Gamal EM**, Metzger P, Szabó G, Bráth E, Petõ K, Oláh A, Kiss J, Furka I, Mikó I. The influence of intraoperative complications on adhesion formation during laparoscopic and conventional cholecystectomy in an animal model. *Surg Endosc* 2001; **15**: 873-877 [PMID: 11443424]

65 **Nagle A**, Ujiki M, Denham W, Murayama K. Laparoscopic adhesiolysis for small bowel obstruction. *Am J Surg* 2004; **187**: 464-470 [PMID: 15041492]

66 **Szomstein S**, Lo Menzo E, Simpfendorfer C, Zundel N, Rosenthal RJ. Laparoscopic lysis of adhesions. *World J Surg* 2006; **30**: 535-540 [PMID: 16555020]

67 **McKay R**. Ileocecal intussusception in an adult: the laparoscopic approach. *JSLS* 2006; **10**: 250-253 [PMID: 16882431]

68 **Morrison JE**, Hodgdon IA. Laparoscopic management of obstructing small bowel GIST tumor. *JSLS* 2013; **17**: 645-650 [PMID: 24398210 DOI: 10.4293/108680813X13X13794522667445]

69 **Watson SD**, Saye W, Hollier PA. Combined laparoscopic incarcerated herniorrhaphy and small bowel resection. *Surg Laparosc Endosc* 1993; **3**: 106-108 [PMID: 8269227]

70 **Deeba S**, Purkayastha S, Paraskevas P, Athanasiou T, Darzi A, Zacharakis E. Laparoscopic approach to incarcerated and strangulated inguinal hernias. *JSLS* 2009; **13**: 327-331 [PMID: 19793471]

71 **Ruscher KA**, Fisher JN, Hughes CD, Neff S, Lerer TJ, Hight DW, Bourque MD, Campbell BT. National trends in the surgical management of Meckel's diverticulum. *J Pediatr Surg* 2011; **46**: 893-896 [PMID: 21616248 DOI: 10.1016/j.jpedsurg.2011.02.024]

72 **Pepper VK**, Stanfill AB, Pearl RH. Diagnosis and management of pediatric appendicitis, intussusception, and Meckel diverticulum. *Surg Clin North Am* 2012; **92**: 505-26, vii [PMID: 22595706 DOI: 10.1016/j.suc.2012.03.011]

73 **Shalaby RY**, Soliman SM, Fawy M, Samaha A. Laparoscopic management of Meckel's diverticulum in children. *J Pediatr Surg* 2005; **40**: 562-567 [PMID: 15793736]

74 **Prasad TR**, Chui CH, Jacobsen AS. Laparoscopic-assisted resection of Meckel's diverticulum in children. *JSLS* 2006; **10**: 310-316 [PMID: 17212886]

75 **Cobellis G**, Cruccetti A, Mastroianni L, Amici G, Martino A. One-trocar transumbilical laparoscopic-assisted management of Meckel's diverticulum in children. *J Laparoendosc Adv Surg Tech A* 2007; **17**: 238-241 [PMID: 17484657]

76 **Clark JM**, Koontz CS, Smith LA, Kelley JE. Video-assisted transumbilical Meckel's diverticulectomy in children. *Am Surg* 2008; **74**: 327-329 [PMID: 18453298]

77 **Lacy AM**, García-Valdecasas JC, Delgado S, Castells A, Taurá P, Piqué JM, Visa J. Laparoscopy-assisted colectomy versus open colectomy for treatment of non-metastatic colon cancer: a randomised trial. *Lancet* 2002; **359**: 2224-2229 [PMID: 12103285]

78 **Guillou PJ**, Quirke P, Thorpe H, Walker J, Jayne DG, Smith AM, Heath RM, Brown JM. Short-term endpoints of conventional versus laparoscopic-assisted surgery in patients with colorectal cancer (MRC CLASICC trial): multicentre, randomised controlled trial. *Lancet* 2005; **365**: 1718-1726 [PMID: 15894098]

79 **Tjandra JJ**, Chan MK. Systematic review on the short-term outcome of laparoscopic resection for colon and rectosigmoid cancer. *Colorectal Dis* 2006; **8**: 375-388 [PMID: 16684081]

80 **Chand M**, Siddiqui MR, Gupta A, Rasheed S, Tekkis P, Parvaiz A, Mirnezami AH, Qureshi T. Systematic review of emergent laparoscopic colorectal surgery for benign and malignant disease. *World J Gastroenterol* 2014; **20**: 16956-16963 [PMID: 25493008 DOI: 10.3748/wjg.v20.i45.16956]

81 **Harji DP**, Griffiths B, Burke D, Sagar PM. Systematic review of emergency laparoscopic colorectal resection. *Br J Surg* 2014; **101**: e126-e133 [PMID: 24285040 DOI: 10.1002/bjs.9348]

82 **Kouhia ST**, Heiskanen JT, Huttunen R, Ahtola HI, Kiviniemi VV, Hakala T. Long-term follow-up of a randomized clinical trial of open versus laparoscopic appendicectomy. *Br J Surg* 2010; **97**: 1395-1400 [PMID: 20632312 DOI: 10.1002/bjs.7114]

83 **Masoomi H**, Mills S, Dolich MO, Ketana N, Carmichael JC, Nguyen NT, Stamos MJ. Comparison of outcomes of laparoscopic versus open appendectomy in children: data from the Nationwide Inpatient Sample (NIS), 2006-2008. *World J Surg* 2012; **36**: 573-578 [PMID: 22270985 DOI: 10.1007/s00268-011-1417-8]

84 **Southgate E**, Vousden N, Karthikesalingam A, Markar SR, Black S, Zaidi A. Laparoscopic vs open appendectomy in older patients. *Arch Surg* 2012; **147**: 557-562 [PMID: 22786544 DOI: 10.1001/archsurg.2012.568]

85 **Cahill RA**. Transgastric appendicectomy (Br J Surg 2013; 100: 911-915). *Br J Surg* 2013; **100**: 915-916 [PMID: 23640667 DOI: 10.1002/bjs.9116]

86 **Frutos MD**, Abrisqueta J, Lujan J, Abellan I, Parrilla P. Randomized prospective study to compare laparoscopic appendectomy versus umbilical single-incision appendectomy. *Ann Surg* 2013; **257**: 413-418 [PMID: 23386239 DOI: 10.1097/SLA.0b013e318278d225]

87 **Litz C**, Danielson PD, Gould J, Chandler NM. Financial impact of surgical technique in the treatment of acute appendicitis in children. *Am Surg* 2013; **79**: 857-860 [PMID: 24069975]

88 **Nash GM**, Bleier J, Milsom JW, Trencheva K, Sonoda T, Lee SW. Minimally invasive surgery is safe and effective for urgent and emergent colectomy. *Colorectal Dis* 2010; **12**: 480-484 [PMID: 19508540 DOI: 10.1111/j.1463-1318.2009.01843.x]

89 **Watanabe K**, Funayama Y, Fukushima K, Shibata C, Takahashi K, Sasaki I. Hand-assisted laparoscopic vs. open subtotal colectomy for severe ulcerative colitis. *Dis Colon Rectum* 2009; **52**: 640-645 [PMID: 19404068 DOI: 10.1007/DCR.0b013e31819d47b5]

90 **Qazi SM**, Skovdal J, Munck LK, Bisgaard T. High morbidity after laparoscopic emergency colectomy for inflammatory bowel disease. *Dan Med Bull* 2011; **58**: A4326 [PMID: 22142568]

91 **Bell RL**, Seymour NE. Laparoscopic treatment of fulminant ulcerative colitis. *Surg Endosc* 2002; **16**: 1778-1782 [PMID: 12098026]

92 **Cirocchi R**, Arezzo A, Vettoretto N, Cavaliere D, Farinella E, Renzi C, Cannata G, Desiderio J, Farinacci F, Barberini F, Trastulli S, Parisi A, Fingerhut A. Role of damage control surgery in the treatment of Hinchey III and IV sigmoid diverticulitis: a tailored strategy. *Medicine (Baltimore)* 2014; **93**: e184 [PMID: 25437034 DOI: 10.1097/MD.0000000000000184]

93 **Wieghard N**, Geltzeiler CB, Tsikitis VL. Trends in the surgical management of diverticulitis. *Ann Gastroenterol* 2015; **28**: 25-30 [PMID: 25608492]

94 **Cirocchi R**, Trastulli S, Vettoretto N, Milani D, Cavaliere D, Renzi C, Adamenko O, Desiderio J, Burattini MF, Parisi A, Arezzo A, Fingerhut A. Laparoscopic peritoneal lavage: a definitive treatment for diverticular peritonitis or a "bridge" to elective laparoscopic sigmoidectomy?: a systematic review. *Medicine (Baltimore)* 2015; **94**: e334 [PMID: 25569649 DOI: 10.1097/MD.0000000000000334]

95 **Koh FH**, Tan KK, Tsang CB, Koh DC. Laparoscopic versus an open colectomy in an emergency setting: a case-controlled study. *Ann Coloproctol* 2013; **29**: 12-16 [PMID: 23586009 DOI: 10.3393/ac.2013.29.1.12]

96 **Choi JM**, Lee C, Han YM, Lee M, Choi YH, Jang DK, Im JP, Kim SG, Kim JS, Jung HC. Long-term oncologic outcomes of endoscopic stenting as a bridge to surgery for malignant colonic obstruction: comparison with emergency surgery. *Surg Endosc* 2014; **28**: 2649-2655 [PMID: 24789126 DOI: 10.1007/s00464-014-3517-7]

97 **Lim TZ**, Chan D, Tan KK. Patients who failed endoscopic stenting for left-sided malignant colorectal obstruction suffered the worst outcomes. *Int J Colorectal Dis* 2014; **29**: 1267-1273 [PMID: 24986142 DOI: 10.1007/s00384-014-1948-1]

98 **Odermatt M**, Miskovic D, Siddiqi N, Khan J, Parvaiz A. Short- and long-term outcomes after laparoscopic versus open emergency resection for colon cancer: an observational propensity score-matched study. *World J Surg* 2013; **37**: 2458-2467 [PMID: 23846176 DOI: 10.1007/s00268-013-2146-y]

**P-Reviewer:** Shouman S **S-Editor:** Ma YJ **L-Editor:** **E-Editor:**

**Table 1 Treatment for acute cholecystitis depending on severity grading**

|  |  |
| --- | --- |
| **Grade** | **Management** |
| Grade I | Early laparoscopic cholecystectomy is the treatment of choice. Conservative treatment is indicated for high-risk patients. |
| Grade II | Laparoscopic cholecystectomy carried out by expert surgeons is preferred. In cases of severe inflammation, the most adequate treatment is emergency laparoscopic cholecystectomy or cholecystostomy. |
| Grade III | The treatment of choice consists of adequate organ support together with medical management and biliary drainage or emergency cholecystectomy. In the event of choleperitoneum after gallbladder perforation, emergency laparoscopic cholecystectomy is the treatment of choice. |

**Table 2 Recommended treatment for acute cholangitis by severity**

|  |  |
| --- | --- |
| **Grade** | **Management** |
| Grade I | Initial medical management suffices in a majority of patients. Patients who do not respond to initial treatment undergo endoscopic, percutaneous or surgical drainage of bile ducts[28]. |
| Grade II | After initiating medical treatment, patients undergo endoscopic, percutaneous or surgical T-tube drainage to avoid a deterioration of their condition. |
| Grade III | Management entails organ supportive treatment together with urgent drainage of bile ducts. Once the patient is stable, endoscopic drainage must be performed. Transhepatic cholangiography (PTC) is indicated when the papilla is inaccessible and as a third-line approach when drainage is not possible or is contraindicated. |

**Table 3 Selection criteria for a laparoscopic approach to incarcerated hernias**

|  |
| --- |
| Criteria for a laparoscopic approach to treatment of an incarcerated ventral hernia[58]: |
| Absence of marked abdominal distension. |
| Absence of peritonitis. |
| Absence of clinical signs of intestinal ischaemia. |
| Absence of high septic risk situations. |
| Absence of major defects with loss of domain. |
| Absence of haemodynamic instability and severe comorbidity. |
| Morbid obesity, old age and debilitation are not considered contraindications to the procedure. |