New Trends in Laparoscopic Procedures in the Emergency Abdominal Surgery

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Key Points

- The greatest advantages of laparoscopy, when compared to open surgery, are already recognized: less post-operative pain, faster and better postoperative recovery, shorter hospital stay, earlier discharge, and earlier return to normal daily, activity, such as physical exercise, and cost of the hospital stay.
- Laparoscopic surgery is extensively used in elective surgery; for emergency surgery, it is still considered too challenging and is not usually recommended.
- Laparoscopic appendectomy (LA) is a well-accepted and can be considered as the gold standard of care in cases of acute appendicitis. Many studies demonstrate LA to be feasible, safe, and effective.
- The prevalence and the superiority of laparoscopic cholecystectomy (LC) over the standard open procedure for the treatment of acute cholecystitis are well-accepted and have been demonstrated in four randomized controlled trials (RCTs). They show that LC in acute cholecystitis is associated with faster recovery and shorter hospital stay, lower morbidity, and mortality.
- Laparoscopic repair for perforated peptic ulcer provides potential advantages over open repair in terms of postoperative morbidity and mortality; published data are sparse and further RCTs with larger sample sizes are needed to arrive at substantiated conclusions.
- For acute diverticulitis (Hichey stages IIb and III), laparoscopic lavage is indicated, with the aim to potentially spare the patient from a major bowel resection and stoma creation. Abundant lavage of the peritoneal cavity and positioning of multiple (at least 2) drains is indicated.
- Laparoscopic adhesiolysis for small bowel obstruction is recommended in selected patients with no more than two prior operations, especially in cases of appendectomy or cholecystectomy.
- Emergent laparoscopic repair of acutely symptomatic paraesophageal hernias is feasible, safe, and effective and may achieve better outcomes. This advantage is even more significant in elderly patients with comorbidities who may receive the greatest advantages from minimally invasive surgery and experience less postoperative pain.
- Laparoscopy may be an accurate diagnostic tool for abdominal trauma for hemodynamically stable trauma patients with doubtful clinical or imaging findings and it is has been demonstrated to be able to decrease the rate of nontherapeutic laparotomies and minimize patient morbidity.
- The only real contraindication to the use of laparoscopy in an emergency setting as an acute care surgery procedure is in patients exhibiting hemodynamic instability and severe hemorrhagic or septic shock.

Surgical practice is continuously evolving mainly because of technologic developments and better-performing instruments. Recent evolution of technology has dramatically changed the range of available instruments and, subsequently, the therapeutic options that can be offered to patients needing surgical interventions and eventually even emergency surgery.

The minimally invasive approach, commonly termed keyhole surgery, refers to a surgical procedure performed through small abdominal incisions as small as those of a

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"door lock," as opposed to the traditionally larger and more painful laparotomy incisions, therefore, captivating the patient's preference. The laparoscopic approach carries several significant advantages for patients, both in terms of much less postoperative pain (every effort should be undertaken to avoid or at least minimize pain), including faster and better postoperative recovery, shorter hospital stay, earlier discharge, and earlier return to normal daily activity, such as physical exercise (including sports and sexual life) and a significantly faster return to work. Therefore, these advantages might not only reduce the costs of the hospital stay for the health systems but also positively influence the social costs, allowing patients to resume their work significantly earlier and avoid long periods of inactivity.

The protocols of ERAS [enhanced recovery after surgery program] have been best applied in conjunction with minimally invasive and laparoscopic procedures.

In recent years, the use of laparoscopy became popular in colorectal surgery and surgical oncology. In this setting, while achieving good oncologic results and satisfying good oncologic quality criteria in terms of radical resections and number of lymph nodes removed, modern laparoscopy currently allows extended colectomies or wide and low rectal resections with total mesorectal excision without negatively affecting oncologic quality indicators such as perioperative morbidity, short- and long-term mortality, local recurrences rate, and tumor stage-related survival rate but rather improving the postoperative quality of life, reducing pain, and improving aesthetic results [1].

The technological improvements in this field include the development and perfection of laparoscopic instruments, including endo-staplers and harmonic scalpels. The development of modern laparoscopic techniques and the acquisition of these skills by a growing number of surgeons have instilled confidence in the procedure. Further progress in laparoscopy has been made by single-incision laparoscopic surgery (SILS). Through a single incision, a vast array of operations can be performed, including cholecystectomies, appendectomies, colorectal resections, and minor liver resections (e.g., left liver lobe resections). In SILS, single incision usually is transumbilical, which accommodates both the camera and two or more operating instruments. More recently, an innovative and challenging technique, natural orifice transluminal endoscopic surgery (NOTES) [2], has been developed with the intent to greatly improve outcomes in terms of cosmetics, diminished postoperative pain, and faster return to normal activity. NOTES consists of performing abdominal interventions by accessing the cavity through natural orifices, such as the stomach, rectum, vagina, or urinary bladder, thereby achieving truly scarless surgery. For the moment, NOTES remains a surgical procedure performed at only a few centers worldwide on highly selected patients [3].

The resected specimen is then extracted through dedicated mini-incisions that can be made even smaller (if an intracorporeal anastomosis is performed, less painful if muscle-splitting rather than muscle-cutting methods are used), and extremely low and concealed (i.e., so-called mini-Pfannenstiel incision in suprapubic site, just below the "bikini" line or level of underwear and, therefore, less apparent). Compared with oblique incisions in the right hypochondrium for right colectomy with eventual extracorporeal anastomosis, in the left iliac fossa for left colectomy, or with enlarged midline umbilical incisions, the suprapubic miniPfannenstiel incision to extract the surgical specimen has been shown to be associated with much a lower incidence of surgical site infections (SSIs) [1]. This kind of SSI often persists for several weeks, requiring repeated wound care, outpatient clinic appointments, delayed wound healing, and eventually even delay to the resumption of normal independent daily living, such as attending to personal hygiene and mobilizing. Furthermore, when associated with intracorporeal anastomosis, a suprapubic mini-incision of a few centimeters carries the risk of postoperative incisional hernia close to 0%,2 which is significantly lower when compared with oblique or midline incisions and hypochondrial or iliac incisions. The transverse muscle-preserving approach or muscle-splitting techniques are also advocated as an alternative for off-midline extraction site, yielding the lowest rate of incisional hernia development.

23.1 Laparoscopy for Abdominal Emergencies

Nevertheless, laparoscopic surgery is extensively used in elective surgery; for emergency surgery, it is still considered too challenging and is not usually recommended. There are numerous reasons such as the laparoscopic skills of the operator usually limited to elective settings, the technical struggle in the presence of diffuse peritonitis, large purulent collections and diffuse adhesions, anesthetic concerns in the presence of comorbidity and older patients, and last but not least, the limited operating room resources during night time and after-hours shifts, because the procedure is limited by time as well as by the accessibility of equipment and surgical personnel, especially in rural hospitals.

These and many more issues contribute to make a laparoscopic approach challenging and risky in an emergency setting and prevent the development of "laparoscopic emergency surgery" [1].

We have, therefore, reviewed the most recent scientific literature on advances in laparoscopy for acute care surgery and trauma in order to demonstrate the current indications and outcomes associated with a laparoscopic approach to the

Table 23.1 Evidence of effectiveness of laparoscopy in acute abdomen [35]

	2006 consensus	2011 consensus
Perforated gastroduodenal ulcer	+++	++
Acute cholecystitis	+++	++
Acute pancreatitis	+	++
Acute appendicitis	+++	+++
Acute diverticulitis	–?	+
Small bowel obstruction	+?	+
Incarcerated hernia	+?	+
Ventral hernias		+
Mesenteric ischemia	–?	–
Gynecologic disorders	+++	+++
Nonspecific abdominal pain	+++	+++
Abdominal trauma	+?/–?	+

+, effectiveness from strongest (+++) to weakest (+); –, no effectiveness; ?, doubtful effectiveness

treatment of the most common emergency surgical conditions (Table 23.1).

23.2 Acute Appendicitis

Laparoscopic appendectomy (LA) was first described back in 1983 [4] and some of its benefits were immediately apparent: superior visualization of the peritoneal cavity, enabling the diagnosis of alternative diseases in the case of a normal appendix and, last but not least, because acute appendicitis is the most common surgical disease in young people, cosmetic considerations [3].

LA is now well-accepted as the gold standard of care in cases of acute appendicitis [5, 6]. Many studies demonstrate LA to be feasible, safe, and effective. These studies show LA to be superior to OA due to shortened hospital stays, lower complication rates, earlier return to work, and resumption of normal activity. LA can be considered the gold standard in premenopausal woman, in the elderly and obese patients. Despite evidence that consider LA safe in pregnancy, advantages are minor when compared to the risk of fetal loss, which seems greater with LA than with OA.

A Swedish national database study, including a large cohort of 169,896 patients comparing LA with OA, evidenced a shorter length of hospital stay, a lower frequency of negative appendicectomy (adjusted odds ratio 0.59; $P < 0.001$), lower rates of wound infection (adjusted OR 0.54; P D 0.004), and wound rupture (adjusted OR 0.44; P D 0.010) associated with LA; on the other hand, laparoscopy carries higher rates of previously infrequent complications, such as intestinal injuries (adjusted OR 1.32; P D 0.042), readmission (adjusted OR 1.10; $P < 0.001$), postoperative abdominal abscess (adjusted OR 1.58; $P < 0.001$), and urinary infection (adjusted OR 1.39; P D 0.020). Moreover, this paper analyzes small bowel obstructions (SBO) during the first 2 years after surgery, proving a lower hospitalization in Las, during the first 2 years following operation [5].

The disadvantages of LA than OA are higher cost and difficult technique and surgical skills if compared to OA. Operative times are predominantly surgeon dependent and increases in the learning curve correlate with a reduction in surgical time. Much of the costs for LA result from the routine employment of staplers as well as disposable devices.

Stapler reduces operative time and superficial wound infection, but not significant differences are evidenced in the rate of intra abdominal abscesses [6].

Although staplers are easy to use, quick, and provide a secure closure of the appendicular stump, equally safe and inexpensive options have been described to secure the stump [7]. Endoloops and intracorporeal knotting have been shown to be alternative methods [8]. Loops are not recommended in cases, where there is a perforated base or when inflammation occurs on the caecum wall. In such cases, a stapler is preferred as the safer method of closure. Economic analyses have been performed for the use of staplers and other disposable devices as well as for the indirect costs associated with lost productivity during hospitalization and subsequent recuperative periods. Considering these costs, studies indicate LA to be less expensive than OA overall. Even when high costs of laparoscopic conversions to open procedures are factored into the cost analysis, LA remains the most cost-effective procedure in use today.

Three-port appendectomy is still the laparoscopic gold standard technique, usually umbilical and two suprapubic trocars. Over the last decade, an innovative technique, SILS, has been spreading with the intent to further improve the impact of minimally invasive surgery in terms of cosmesis, postoperative pain, and return to normal activity [9].

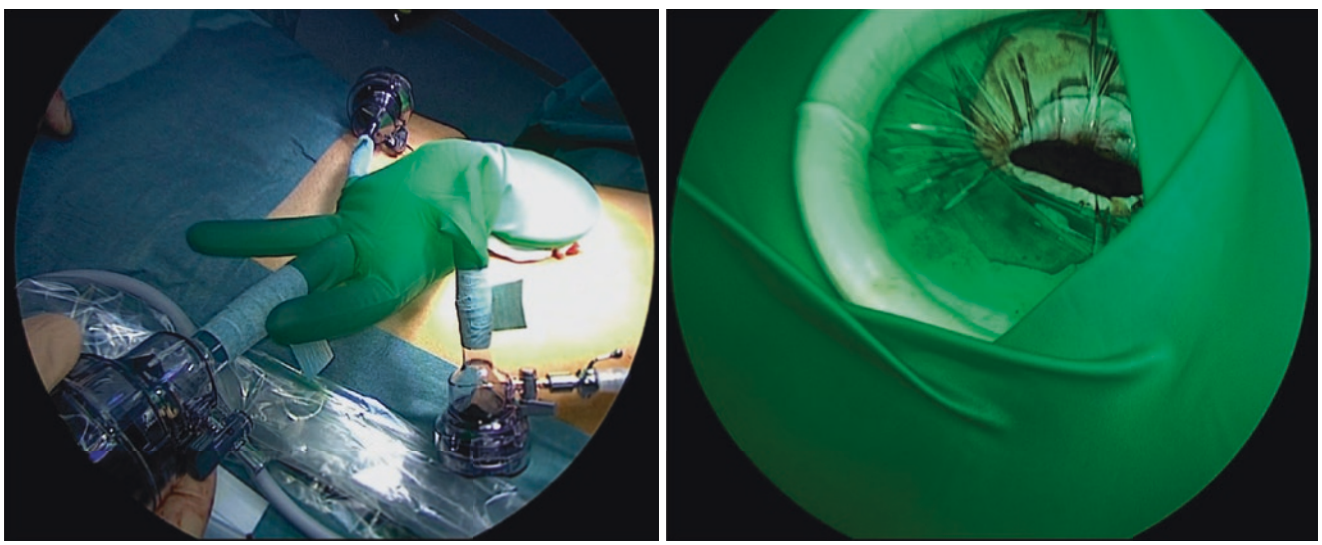
Several studies and randomized trials have tested and compared single incision LA (SILA) with LA showing similar postoperative results [10]. Single-port appendectomy is still inferior to the standard three-port technique: increased costs than LA, and the use of angled instruments and the loss of triangulation between them, due to coaxiality, makes SILS a difficult procedure requiring advanced laparoscopic skills. These factors may be associated with an increased rate of postoperative complications and longer surgical times.

As for cosmetic results related to the reduced number of incision and the length of hospital stay and return to normal activity, SILA recovery time is nearly equal to LA and is, therefore, not a singularly decisive factor in choosing one procedure over the other.

More recently, however, a few authors have described a novel, self-made, and inexpensive single-port laparoendoscopic single-site surgical method. Made using a surgical glove (Fig. 23.1), this easy-to-make single-port laparoscopy carries some great advantages: it is associated with significantly decreased costs compared to commercial single-port equipments and it requires just the use of common laparoscopic standard straight instruments with reduced coaxiality without need of laparoscopic instruments with curved architecture which are more expensive and less widely available in the community hospital. This means more working space and wider feasibility for this modified single incision laparoscopic technique. Surgical glove port has been adopted for several minimally procedures, including cholecystectomies and appendectomies [9] (Figs. 23.1, 23.2, and Fig. 23.3).

NOTES appendectomy, principally performed via transvaginal route in women with uncomplicated appendicitis, has seen a growing interest from surgeons from all over the world, but it is actually debates.

Fig. 23.3 Outcomes of SILS appendectomy for gangrenous appendicitis with a low cost surgical glove port in a young patient with multiple tattoos on both sides of the abdomen. The 1.8 cm umbilical incision used for wound protector insertion and surgical glove port SILS. The appendiceal specimen is then extracted and stored within a glove finger



Figs. 23.1 and 23.2 Gloves single port

23.3 Acute Cholecystitis

All the recent guidelines consider laparoscopic cholecystectomy (LC) as the gold standard for the treatment of acute calculous cholecystitis.

Acute calculous cholecystitis is one of the most common conditions faced by a general surgeon. Gallstones are estimated to affect about 10–15% of Western populations, of which 1–4% will develop acute cholecystitis or symptomatic cholelithiasis every year. In the US, about 1.5 million cholecystectomies are performed annually, of which 70–90% are carried out laparoscopically [10].

The prevalence and the superiority of LC over the standard open procedure for the treatment of acute cholecystitis are well-accepted such as has been demonstrated in four randomized controlled trials (RCTs). They show that LC in acute cholecystitis is associated with faster recovery and shorter hospital stay, lower morbidity, and mortality. Among the complications, wound infection, pneumonia, and bile leakage deserved a separate inquiry: the wound infection and pneumonia rate favored laparoscopic surgery, while the bile leakage did not differ significantly between the two groups. These data represent a strong support for the role of LC as the gold standard in the treatment of the acute calculous cholecystitis.

The optimal timing of surgery in cases of acute cholecystitis has always been a topic of debate, because until recently, LC is associated with higher morbidity rates and higher conversion rate to open procedure in emergency procedures. For this reasons, in the past, patients were managed conservatively with initial antibiotic treatment and resuscitation for the purpose of cooling down the inflammatory process and followed by elective laparoscopic surgery about 6 weeks after the acute attack [11]. Current data suggest that early LC for acute cholecystitis is superior to late or delayed LC in terms of outcome and costs. During the first 72 h, surgical dissection may be easiest because of the lack of organized adhesions, reducing the risk of bile duct injuries and decreasing the rate of complications. The concept of early cholecystectomy has now been discussed by some authors: although guidelines recommend LC within the first 48–72 h after symptom onset, should be considered the "golden hours", a recent randomized trial has showed LC performed within 24 h of admission to be superior when compared to delayed LC [12].

Transumbilical single-incision LC (SILC) has recently been introduced with the intent to improve cosmetic results by leaving no visible exterior abdominal scars. Since the surgical evidence is hidden within the umbilicus, SILC subsequently decreases postoperative pain and accelerates postoperative recovery as well. Interestingly, however, randomized trials comparing SILC vs LC showed no differences in post-operative pain. SILC has been associated with slightly longer surgical times, mostly due to the advanced laparoscopic skills required to perform it, the procedure may also negatively affect postoperative complication rates and despite the smaller skin incision in SILS, the total size of fascial defects may be equal to the size required for classic laparoscopy and increased risk of development incisional hernia. SILC may be considered as a safe alternative to LC for the treatment of gallstone-related disease in selected uncomplicated patients. However, further study will be required before widespread use of this technique can be advocated [13].

Several studies confirm that LC, such as EAES guidelines published in 2012, is indicated also for empyema, perforated or gangrenous cholecystitis, despite likely to be associated with increased operative difficulty [14].

23.4 Perforated Peptidic Ulcer

Peptic ulcer remains the most common cause of gastroduodenal perforation, with incidence ranging from 2% to 10% of abdominal emergencies. This is attributed to the increasingly widespread use of anti-inflammatory drugs, especially in the elderly with considerable comorbidity, where a high mortality rate (up to 25%) and a morbidity rate of up to 50% have been reported, even in recent studies [15].

The surgical treatment of PPU consists of the repair of gastric or duodenal defects by primary suture, omentum patch, synthetic material patch, or resection. There is some variability of the techniques used in laparoscopic repair of the PPU and the ideal technique should respond to some basic requirements, such as the relative easy of implementation with reduced operating times and reliability, in terms of reduced morbidity (in particular of reducing the risk of leakage). The criteria to choose the method of closure basically depend on the characteristics of the lesion [16]: in case of ulcer edges easily closed without tension, just the simple suture with any omentum plastic is enough; instead, if the margins are edematous or little sliding, the repair will be done by affixing omental patch.

The attempt to laparoscopically repair a PPU was first described at the beginning of the laparoscopic era many years ago [17]. The laparoscopic approach to PPU has several advantages, including the confirmation of the diagnosis, the subsequent identification of the ulcer and possibly its closure, with lavage of the peritoneal cavity, all without the need for a laparotomy. Throughout the most recent literature, laparoscopy has emerged as a feasible and safe, effective alternative to the traditional open treatment of PPU, if conducted by expert operators on properly selected patients [18]. Notwithstanding, only a few randomized trials were con-

ducted comparing laparoscopic vs open repair of PPU and none of them reported statistically significant differences with regard to post-operative pain or complications [19]. The exception to this is a recent randomized, controlled trial showing laparoscopic repair of PPU to be associated with decreased post-operative pain, hospital length of stay, and morbidity. Although laparoscopy for PPU provides potential advantages over open repair in terms of postoperative morbidity and mortality [20], published data are sparse and further RCTs with larger sample sizes are needed to arrive at substantiated conclusions.

23.5 Acute Diverticulitis

Nowadays, colonic diverticula affect approximately 60% of people over 80 years, but of these only 4% of them will eventually develop an acute episode of diverticulitis.

The diagnosis of acute diverticulitis can be suspected clinically by physical examination and blood count findings and can be confirmed by CT scan. Uncomplicated disease is defined as an inflammatory process limited to the colon, including signs, such as wall thickening and inflammation of the pericolic fat. Patients with acute uncomplicated diverticulitis should be treated conservatively with antibiotics and not undergo emergency surgery [17]. Complicated cases of diverticular disease are classified according to the modified Hinchey classification. Stage I indicated the presence of a pericolic abscess of less than 4 cm without peritonitis and can be managed successfully with broad-spectrum antibiotics, bowel rest, and observation only. Stage IIa indicates distant abscess amenable to percutaneous drainage, stage IIb indicates complex abscess with or without fistula, and diffuse peritonitis is classified as stage III (purulent) or stage IV (fecal). For stage IIa, percutaneous drainage or only medical treatment usually is effective.

Since some years ago, the traditional surgical treatment of Hinchey III and IV patients includes open sigmoid colon resection with end colostomy and left hemicolectomy with primary anastomosis with or without diverting stoma. Early postoperative mortality rate is about 10–20% after both sigmoid resection and end colostomy and resection and primary anastomosis. In addition, up to 70% of patients undergoing nonrestorative resection do not have their colostomy reversed and the anastomotic leakage rate reported in the literature after primary anastomosis is as high as 14% [18]. In 1996, a minimally invasive approach to patients with Hinchey III diverticulitis based on intravenous antibiotics and laparoscopic peritoneal lavage was proposed to avoid urgent resective surgery.

For stage IIb and III, laparoscopic lavage is indicated, with the aim to potentially spare the patient from a major bowel resection and stoma creation. Abundant lavage of the peritoneal cavity and positioning of multiple (at least 2) drains is indicated.

The search for the perforation should not be pursued at all costs; when a large leak is automatically evident, a fecal fistula is usually present or will appear after the operation and the patient should be managed with colonic resection. However, if a small colonic perforation is found during lavage, a suture can be attempted, eventually reinforced with an omental patch. In case of a concomitant fistula with bladder and/or small bowel fistula and stenosis, lavage and drainage may allow elective management by the open or the laparoscopic approach, according to the preference of the surgeon. This strategy, which aims to convert generalized purulent peritonitis to localized diverticulitis that can be safely treated with antibiotic therapy, is successful in most cases (90%), with immediate improvement of the clinical conditions of the patient, and is associated with decreased mortality and morbidity (dehiscence, infection, and incisional hernia. Hinchey III patients in whom exploration of the abdomen is not satisfactory because of adhesions or obstruction and patients with severe peritonitis with numerous false membranes should be considered for conversion to open surgery or should undergo laparoscopic emergency colonic resection, but only if performed by experienced hands. Of note, elective resection of the diseased segment decreases the risk of conversion and increases the rate of primary anastomosis compared to emergency surgery [19, 21, 22].

In Hinchey, stage IV colonic resection can be performed laparoscopically by experienced hands [23].

23.6 Small Bowel Obstruction

Abdominal adhesions are the most common cause of intestinal obstruction, responsible for 60–70% of SBO [24]. Laparotomy is one of the most important causes of adhesions in the abdominal cavity. In 1990, Clotteau first reported on laparoscopic adhesiolysis for SBO secondary to adhesions. The main advantages of laparoscopy vs open surgery for SBO concern the postoperative recovery, as well as the reduced rate of postoperative laparotomy-related adhesions and ventral hernia [25].

Higher rates of reoperation, unrecognized enterotomy, and inability to properly evaluate compromised bowel have all been cited as disadvantages to laparoscopic intervention for SBO [26]. In addition, a higher rate of bowel injury associated with laparoscopy for SBO has been reported [22]. This likely depends on the grade of adhesions, surgeon experience, the use of thermal coagulation for dissection, and the impaired tactile feedback during laparoscopic manipulation [27].

A systematic review that included all papers published up to 2007 (1236 patients) found a successful therapeutic laparoscopy rate in the range of 40–88% and a conversion rate ranging from 0% to 52% [28, 29].

Laparoscopic adhesiolysis for SBO is recommended in selected patients with no more than two prior operations, especially in cases of appendectomy or cholecystectomy, with a suspected single band obstruction and early onset of symptoms, and small bowel loop diameter >4 cm [28, 30–32].

23.7 Ventral Hernias

After postoperative peritoneal adhesions, these diseases are the second most common cause of occlusion of the small intestine and, therefore, deserve some considerations aside. Complications such as incarcerations or strangulation may occur in 5% of cases. Urgent surgical procedures may be required in 5–13% of incarcerated abdominal wall hernia cases and intestinal resections may be required in 10–15% [33, 34].

In 2012, the Consensus Development Conference on Laparoscopic approach to acute abdomen (SICE, ACOI, SIC, SICUT, SICOP, and EAES) confirmed that the laparoscopic approach to incarcerated ventral and incisional hernias may be performed in selected patients. Good experience in emergency surgery and in laparoscopic repair of the abdominal wall in elective patients is always strictly required [35].

Patients should be sected for laparoscopic repair according to the following criteria [36]:

- absence of marked abdominal distension, bowel distension with a diameter >5 cm increase risk for conversion to open surgery,
- absence of peritonitis and absence of clinical signs of intestinal ischemia,
- absence of high-septic-risk situations, such contaminated skin lesions or enterocutaneous fistulas,
- absence of major defects with loss of domain or hernias that do not allow the laparoscopic approach with adequate overlap of the mesh,
- absence of hemodynamic instability and severe comorbid conditions,
- morbid obesity.

23.8 Incarcerated/Strangulated Hernias

In lifetime, the risk of having a groin hernia repair has been estimated to be 27% for men and 3% for woman. Of these, only 0.29–2.9% of cases became incarcerated.

In 1993, Watson and colleagues demonstrated the feasibility of laparoscopic groin repair. From this, laparoscopic repair demonstrated the own superiority inguinal or femoral hernia repair.

The mini-invasive repair of rare abdominal wall acute hernias, such as supravesical and spigelian, is rarely described, although there are several articles on the laparoscopic repair of incarcerated internal hernias, such as the paraduodenal, paracecal, broad uterus ligament, transmesosigma, and iatrogenic (caused by surgical changes to the anatomy) hernias.

The acute incarceration of paraesophageal hernias can be a life-threatening surgical emergency; it often occurs in elderly patients with significant comorbidities who have historically been treated with open abdominal or thoracic incisions, both of which are associated with significant morbidity and mortality [37]. However, emergent laparoscopic repair of acutely symptomatic paraesophageal hernias, even when large and incarcerated or strangulated, is feasible, safe, and effective and may achieve better outcomes [38]. This advantage is even more significant in elderly patients with comorbidities who may receive the greatest advantages from minimally invasive surgery and experience less postoperative pain [1].

23.9 Abdominal Trauma

Trauma patients are particularly frail, since most of them have multiple organ injuries.

Laparoscopy may be an accurate diagnostic tool for abdominal trauma, because it is particularly useful in the diagnostic of intra-abdominal organ injuries for hemodynamically stable trauma patients with doubtful clinical or imaging findings and it is has been demonstrated to be able to decrease the rate of nontherapeutic laparotomies and minimize patient morbidity [39–41]. The peritoneal cavity should be examined systematically, beginning with the right-upper quadrant and proceeding clockwise, taking advantage of patient-positioning manipulations. Suction/irrigation may be needed for optimal visualization, and methylene blue can be administered to help identify gastrointestinal injuries. In penetrating injuries, peritoneal violation can be determined. The surgeon should not hesitate to convert to an exploratory laparotomy if he or she is not confident that there are no missed injuries [42]. Therapeutic laparoscopic options have increased in the last few years to manage hemoperitoneum, diaphragmatic, mesentery, and hollow viscus injuries and to avoid nontherapeutic laparotomy, and to treat perforating stab wounds of the gastrointestinal tract that can be sewn or stapled safely when laparoscopic expertise is available [43]. Procedure-related complications occur in up to 11% of patients. Tension pneumothorax in patients with diaphragmatic injury from positive-pressure pneumoperitoneum; gas embolism in patients with intra-abdominal venous

injuries, especially in liver lacerations; and the transperitoneal absorption of carbon dioxide (which may cause metabolic and hemodynamic changes such as acidosis, cardiac suppression, atelectasis, subcutaneous emphysema, and increased intracranial pressure) might result in more profound and in some cases life-threatening consequences for the trauma patient and, as a consequence, clearly limits the potential indications for exploratory laparoscopy to a small number of very selected cases.

In these patients in fact, inflicting less trauma using laparoscopy may represent a significant potential for decreasing the further release of proinflammatory elements with secondary injury to lungs and kidneys, in addition to what is already caused by their primary traumatic injury [44].

23.10 Contraindication

The only real contraindication to the use of laparoscopy in an emergency setting as an acute care surgery procedure is in patients exhibiting hemodynamic instability and severe hemorrhagic or septic shock. The induction of pneumoperitoneum and venous flow return compromise may be easily fatal in such cases. A further relative contraindication to be considered remains a severe respiratory failure with severe hypercapnia, owing to the possible reabsorption of CO_2 and development of malignant hypercapnia and toxic shock syndrome. However, a wise ventilatory strategy, increasing the minute volume of ventilation, and further measures by decreasing the intra-abdominal pressure and the angle of Trendelenburg position might be helpful in mitigating these challenges. For the remaining categories of patients, provided that they are hemodynamically stable and not in septic or hemorrhagic shock, the benefits of laparoscopy and minimally invasive techniques result in an exponential increase of the advantages in terms of postoperative recovery and fewer wound complications. These benefits are relevant not only in young patients but, contrary to commonly held beliefs, even more significant in the elderly patients. The advantages of laparoscopy will be greater in an elderly patient presenting with diffuse peritonitis, who may avoid a large and painful laparotomy incision. Avoiding a median laparotomy incision can also significantly decrease the risk of wound infection and dehiscence. Laparotomy is invariably associated with significant postoperative pain, which can cause cardiovascular and respiratory complications (less depth and effectiveness of breathing as a consequence of attempting to reduce pain at every movement, ultimately leading to an increased risk of atelectasis and pneumonia) as well as circulatory complications (delayed mobilization with consequent increased risk of deep venous thrombosis and possible pulmonary embolism). All these negative consequences will be much more significant in an elderly patient compared with a young patient who undergoes a small open appendectomy for a slightly inflamed appendix or a simple open cholecystectomy for gallstones, requiring limited open surgical incisions (i.e., Mc Burney or Lanz incision or a right subcostal) [1].

The Future Challenge: Development of a New Branch Bridging Between Laparoscopy and Emergency Surgery.

If the recent concept of emergency surgery has evolved and merged into the entity of acute care surgery [45], where the surgeon has specific skills and dedicated education [46], the new concept of “acute care laparoscopy” is emerging, where the surgeon should be able to combine the skills and experience of both acute care emergency surgery with laparoscopic ability and minimally invasive techniques. Emergency laparoscopy is now becoming a new discipline, aiming to join together the difficult issues of emergency surgery with the potential advantages of minimally invasive surgery techniques. This new branch, bridging laparoscopy and emergency surgery, has the potential to extend the advantages, traditionally limited to the elective patients, to a wider population of patients, often older and with comorbidities, presenting with acute abdomen or acute surgical conditions [1].

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