Laparoscopic management of acute abdominal emergencies

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Abstract

Use of minimally invasive approaches to acute abdominal surgical emergencies has increased in recent decades. Uptake has been slower than for elective surgery, however, with concerns regarding inadvertent injury and operative time being most frequently cited. Laparoscopy for abdominal pain has shown to be safe and is a useful diagnostic procedure in the context of unexplained abdominal pain. Minimally invasive surgery has also been shown to be the approach of choice in appendicitis and cholecystitis. Laparoscopy has shown to be useful in trauma patients and may obviate the need for laparotomy. Management of perforated peptic ulcers has shown to be feasible and safe, with some uncertainty as to the superiority over an open approach. The management of perforated diverticulitis has been the subject of much debate, with significant risk possibly associated with minimally invasive lavage. Small bowel obstruction may also be managed using laparoscopy but the potential for inadvertent injury remains. While useful and certainly yielding benefits in terms of postoperative recovery when performed without incident, the decision to proceed minimally invasively in many acute abdominal emergencies must be taken by clinicians and surgical teams with suitable experience and expertise.

Keywords Abdominal emergencies; appendicitis; cholecystitis; diverticulitis; laparoscopy; obstruction; pain; trauma; ulcer

Introduction

Minimally invasive approaches to planned abdominal operations have developed significantly over the past three decades. There is a wealth of scientific evidence that supports the use of laparoscopic techniques in many fields of elective general surgery. Laparoscopic cholecystectomy and colorectal surgery are now routine, and there are several other fields where it has become a mainstay of treatment.

There has been a slower uptake with regards to laparoscopy in the acutely unwell general surgical patient. Historical concerns cited that set up was time consuming, operations took longer to perform, and that inadvertent injury to abdominal structures was more likely. This was all seen as detrimental to someone potentially unstable who required an operation.

Greater exposure of theatre teams, standardization of surgical training and extensive comparative research has found, however, that laparoscopy can both be a useful adjunct to emergency surgery as well as an excellent tool to perform complicated emergency operations.

This article aims to discuss the evidence base for laparoscopic approaches to common emergency surgical problems. Each section will present recent data regarding the particular surgical problem and areas of controversy will be highlighted. Potential pitfalls and risks will be discussed, and then an accepted surgical technique will be described.

Diagnostic laparoscopy for abdominal pain

Diagnostic laparoscopy is a minimally invasive surgical approach for the diagnosis of intra-abdominal disease. It should be considered where the diagnosis and cause of pain remains unclear despite baseline blood tests and radiology, for example a CT scan. In this context, a laparoscopy can avoid a delay to treatment and avoid the need for laparotomy. The procedure enables direct inspection of abdominal viscera, facilitates therapeutic intervention and obtaining intra-abdominal specimens for culture and biopsy.

Diagnostic accuracy for the procedure is excellent, with diagnoses being confirmed in up to 99% of patients. The procedure is safe, with low morbidity (0%–24%) and mortality (<1%) and has been shown to reduce length of hospital stay.

Appendicitis is not addressed in this section of the article and is discussed separately.

Relative contraindications include patients with severe abdominal distension, and adhesions from previous surgery. Haemodynamic instability would commonly be considered an absolute contraindication.[1]

Inspection of intra-abdominal contents must be systematic, thorough and must include:

1. The surface of the liver
2. Gallbladder
3. Stomach
4. Small and large intestine
5. Appendix
6. Uterus and fallopian tubes
7. Visible retroperitoneal structures
8. An examination for free intraperitoneal fluid

It should be noted that diagnostic laparoscopy is not only useful in the context of a new emergency presentation. Patients often undergo 're-look laparoscopy' following a minimally invasive procedure when not progressing as expected postoperatively. The procedure can identify, for example, anastomotic leak following colorectal surgery, bile leak following cholecystectomy or inadvertent bowel injury during other procedures. Some therapeutic interventions can also be taken, for example the insertion of drains under direct vision. Given the

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comparatively lower morbidity of laparoscopy versus a laparotomy, 're-look laparoscopy' is increasingly becoming part of the armoury of a general surgeon.

Appendicitis

Appendicectomy has been a mainstay of surgical treatment for many decades. Since the 1990s, an increasing number of operations have been performed laparoscopically. In the case of appendicitis, two distinct categories exist, perforated and non-perforated. Laparoscopy was initially viewed as a contraindication due to the severity of inflammation and potential for diffuse abdominal collections in the perforated cohort. However, as operative skill and equipment have advanced this notion has since been dispelled.

Laparoscopy has bought many benefits. Firstly, the diagnosis of appendicitis is not always certain, as evidenced by a negative appendicectomy rate of up to 20% in the UK. An open operation therefore limits the possibility for inspecting abdominal viscera in the presence of a normal appendix. When performed laparoscopically, a full diagnostic laparoscopy is possible. This is particularly helpful in female patients, who may have ovarian or fallopian tube pathology mimicking appendicitis. Further potential benefits of a minimally invasive approach include reduced postoperative pain and wound infection rates, and shorter time for return to normal daily activities.

A 2018 Cochrane review assessed 85 studies and nearly 10,000 patients. Adults undergoing laparoscopic appendicectomy reported better pain scores and suffered from fewer wound infections. Hospital stays were shorter by 1 day and return to normal activities occurred 5 days earlier. The difference in children was less marked, but hospital stay was shortened and pain scores lower.

It seems, therefore, that laparoscopic appendicectomy should be offered where possible and not clinically contraindicated. It should be borne in mind that the review did suggest an increased incidence of intra-abdominal abscesses after laparoscopic appendicectomy in adults, but not in children.[2]

Operative technique

Classically, the operation involves the use of at least one 10- or 12-mm port and two other ports of varying sizes (either two 5-mm ports or one 10-mm port and two 5-mm ports). The appendix is mobilized from adherent structures by blunt dissection. If in a retrocaecal position, the right colon may need to be mobilized.

The mesoappendix must then be dissected out and the appendiceal artery secured. The mesoappendix can either be dissected away in a 'top-down' approach, separating it from the appendix. Alternatively, the mesoappendix can be dissected out at the base of the appendix and the artery secured. Both techniques are shown in Figure 1a,b.

Haemostasis may be achieved using diathermy, energy devices or laparoscopic clips. The base of the appendix must then be identified. Two Roeder knots (or Endoloops™) can be used to secure the appendix before division. The author recommends delivery of the appendix in a laparoscopic retrieval bag to avoid contamination. Conversion to an open procedure should be considered in case of haemorrhage, patient instability, a failure to progress or inadvertent visceral injury.

Diagnostic laparoscopy in trauma

This is a potentially useful procedure that may obviate the need for laparotomy — trauma patients have high rates of negative laparotomy. Indeed, negative laparoscopy rates have been reported at over 50%. Evidence relating to the feasible and practical utilization of diagnostic laparoscopy in both blunt and penetrating abdominal trauma exists.

The recommendation and evidence for this section is based on the guidance published by the Society of American Gastrointestinal and Endoscopic Surgeons (SAGES) in 2010, titled 'Guidelines for Diagnostic Laparoscopy'. This document's recommendations are the result of an exhaustive literature review that makes indispensable reading for an emergency surgeon.[1]

Utilization of this technique should be exercized with caution. A laparoscopy would not be suitable in a 'crashing' patient where significant vascular trauma is suspected.

In a more stable patient, a trauma CT scan would almost always be performed prior to the use of diagnostic laparoscopy. A CT scan showing significant injury, for example with significant free fluid and pneumoperitoneum, would necessitate a laparotomy.

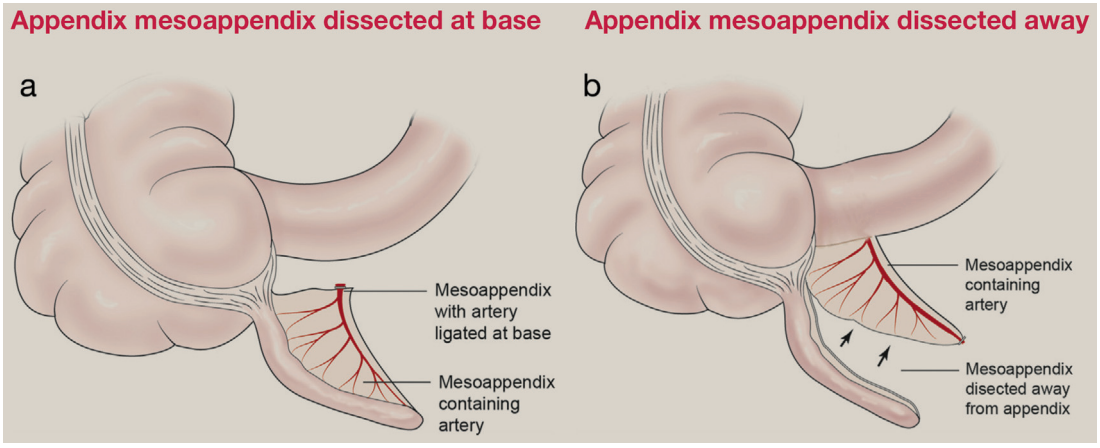

Figure 1

Diagnostic laparoscopy may be useful where CT findings are equivocal, but clinical assessment of the patient suggests missed or developing pathology. The procedure may also be useful in penetrating injuries where peritoneal breach is doubted. Lastly, the procedure is useful for suspected diaphragmatic injuries in thoracoabdominal trauma, where negative radiology is common.

Trauma teams must be aware of the possibility of pneumoperitoneum causing a tension pneumothorax in patients with an undiagnosed diaphragmatic injury, and take appropriate mitigating measures, for example, the insertion of surgical chest drains. Teams must also be aware of the possibility of gas embolism from major vascular injury, which may be catastrophic.

Diagnostic accuracy of the procedure has regularly been reported at above 90%, and many studies have demonstrated the safety and feasibility.

Inspection of the abdominal cavity must be thorough and systematic. Therapeutic intervention is possible at diagnostic laparoscopy, where injuries are focal and contamination minimal; a small bowel injury may be controlled with sutures and drains may be placed, for example. Any doubt regarding missed pathology, or the suitability of the injury for minimally invasive repair would necessitate conversion to laparotomy. In a recent study, the most common reason for conversion to laparotomy was continuous intra-abdominal bleeding. It was followed by multiple complex injuries, haemodynamic instability and poor intraoperative visualization.[3]

Patients must be closely monitored following diagnostic laparoscopy and the possibility of missed injuries considered.

Perforated peptic ulcer

Laparoscopic repair of a peptic ulcer was first described in 1990 and is perhaps one of the most suitable emergencies to be tackled with minimally invasive methods. Contamination from the upper GI tract is most commonly bilious and is more amenable to laparoscopic control than faecal peritoneal soiling. Defects are often small for which laparoscopic suturing is appropriate, and resection of any viscera is rarely required making the creation of an extraction site unnecessary.

The benefits, safety and feasibility of the laparoscopic versus the open approach has been the subject of much research. Four meta-analyses have been conducted which have been somewhat contradictory. Two meta-analyses found short-term benefits, for example lower postoperative pain and wound morbidity.[4,5] One of these, found longer operation times and an increased rate of suture line leakage.[4] One meta-analysis found no difference between the two approaches.[5] The most recent meta-analysis, published in *Nature*, found a lower incidence of postoperative complications, reduced hospital mortality, reduced length of hospital stay, improved postoperative pain, similar re-operation rates and similar operative time.[6] The most recent Cochrane review found no difference between open and laparoscopic surgery in terms of postoperative septic or pulmonary complications.[7]

Operative technique

Open or laparoscopically, the operation requires thorough lavage of the peritoneal cavity, closure of the ulcer with sutures, placement of an omental patch (or both), and the insertion of an appropriately sized drain in the case of suture line leakage (Figure 2). Gastric ulcers require biopsy due to the increased risk of malignancy. Rarely, very large defects can be found that are not suitable for simple suture or patch repair. Specialist upper gastrointestinal opinion must be sought in these cases.

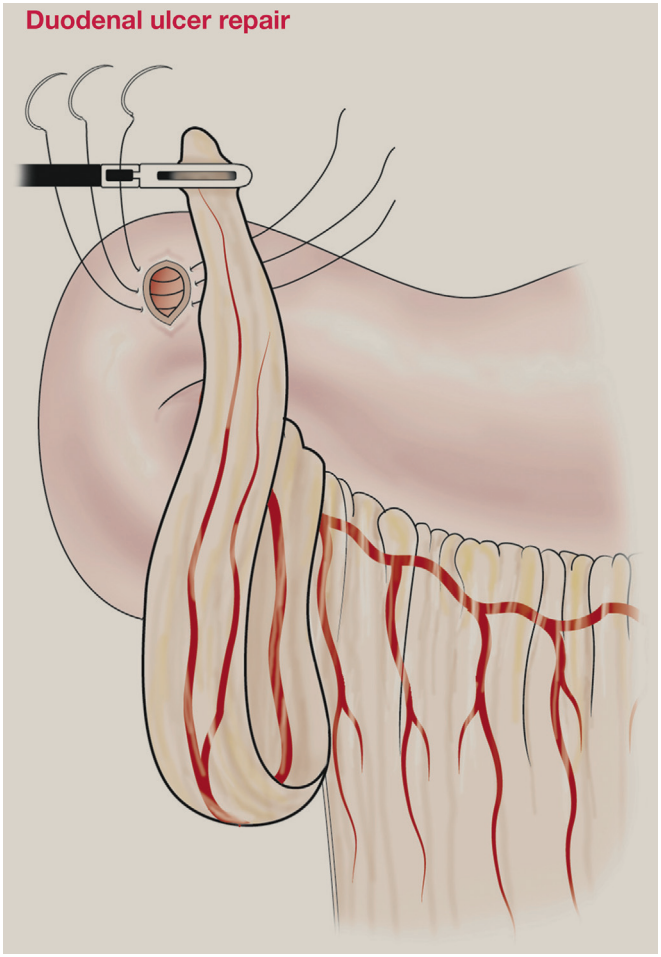

Figure 2

Suggested port placements and an operative diagram for laparoscopic repair of duodenal ulcer is shown in Figure 3.

Diverticulitis

Until recent years, the diagnosis of a diverticular perforation requiring operative management was treated with a Hartmann's procedure. The advent of laparoscopy, improved access to CT scanning and interventional radiological procedures has changed treatment algorithms, but a Hartmann's is still a safe, accepted modality of treatment.

Classically, diverticulitis was assessed according to the Hinchey Classification. Given that many of those findings were dependent on operative findings, more modern, CT-based classification systems have been devised. Both of these are summarized in Table 1.

For localized abscesses of sufficient size (Hinchey 1b, Sartelli 2A) percutaneous radiological drainage is often an appropriate management strategy. Clinicians should bear in mind that recurrence rates are high, and that failure of this approach may necessitate operative management.

There are many proponents of laparoscopic washout and drainage for pelvic abscesses, intra-abdominal abscesses, and

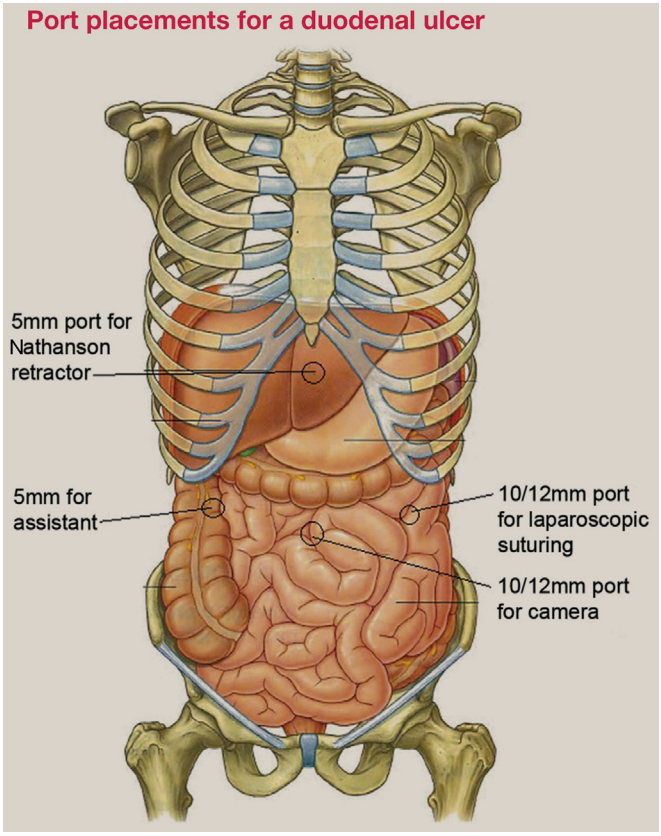

Figure 3

generalized purulent peritonitis. This approach is understandable as it avoids the significant risks and considerable lifestyle changes resulting from a Hartmann's procedure. Opponents of laparoscopic washout however cite the difficulty in ruling out persistent perforations in the colon and the potential for missed malignancy.

Data available regarding laparoscopic lavage is not without controversy, and is at best mixed. Three trials compared the technique with sigmoid resection, with or without a stoma.

The SCANDIV trial compared 199 patients, finding similar mortality and morbidity rates, but found that lavage patients required more re-operations and that more cancers were missed in this cohort.[8] The LOLA trial compared 90 similar patients but was halted early due to significantly higher 30-day morbidity and re-operation rates in the lavage group.[9] The DILALA trial compared 83 patients, finding similar 30-day morbidity and re-operation rates. The trial found a higher re-operation rate at 1 year in the Hartmann's group, but this was almost entirely accounted for by reversal of Hartmann's operations rather than due to severe morbidity.[10]

Given the contradictory nature of the data, laparoscopic lavage should be used with caution and with senior clinician input.

In terms of resectional surgery in the acute setting (a sigmoid colectomy with or without a defunctioning ileostomy, or a Hartmann's procedure), much data exists to show that this can be performed safely minimally invasively without increased risk to the patient. A 2017 Cochrane review of three RCTs found that there was no significant difference between both approaches, but cited the need for more work in this area.[11]

Studies have been undertaken evaluating Hartmann's procedure with primary anastomosis and diverting loop ileostomy for Hinchey III and IV patients, including those performed laparoscopically. Systematic reviews and meta-analyses of randomized trials in 2018 and 2019 concluded that both procedures were acceptable, with similar major complications and mortality rates.[12] No consensus relating to preference for or without a covering stoma exists, and it appears left to each individual surgeon's prerogative.

There has been a growing trend toward performing laparoscopic Hartmann's procedure in recent decades. The systematic review by Cirocchi et al. evaluating the role of the emergency laparoscopic colectomy for complicated sigmoid diverticulitis highlight 4 non-randomized control trials encompassing 436 patients.[13] The laparoscopic approach conferred significant advantages over the traditional open procedure in terms of postoperative complication rates. It should be noted that operation time, reoperation rate and postoperative 30-day mortality were not improved.

Diverticulitis classifications

Score/stage (Hinchey/Sartelli)	Modified Hinchey Classification	CT-based scoring system (Sartelli)
0	Mild clinical diverticulitis	N/A
Ia/1A	Localized pericolic inflammation or phlegmon	Pericolic air bubbles/fluid without abscess
Ib/1B	Pericolic/mesenteric abscess	Abscess <4 cm
II/2A	Pelvic, intra-abdominal or retroperitoneal abscess	Abscess >4 cm
2B	N/A	Distant air (>5 cm from inflamed bowel segment)
III/3	Generalized purulent peritonitis	Diffuse fluid but no free air (no ongoing hole in colon)
IV/4	Generalized faecal peritonitis	Diffuse fluid with distant free air (persistent hole)

Table 1

Operative technique

A suitable technique for a laparoscopic operation is as follows. Patients are placed in a modified lithotomy position. Port placements are variable depending on surgeon preference, with at least two 10- or 12-mm ports for a camera and a laparoscopic stapling device. If peritoneal soiling is contained, lavage may be deferred until after the resection has been completed. If diffuse or large amounts of faecal soiling are present, lavage should be undertaken immediately and conversion to open surgery considered. It would be common practice for wide-bore drains to be left at least in the pelvis.

The sigmoid colon is mobilized along the peritoneal reflection of Toldt; mobilization of the splenic flexure may be necessary in order to facilitate a tension-free stoma or anastomosis if that is the chosen operative strategy. The inferior mesenteric artery must then be dissected, exposed and ligated with laparoscopic vascular devices: staplers, clips or an ultrasonic haemostatic energy device. The colon is then divided distally at the recto-sigmoid junction (below the site of perforation) and proximally at the distal descending colon — proximal to the site of diverticular disease of possible.

If an end stoma is to be formed, this can be formed in the left iliac fossa. This may also be used as a site for exteriorization of the bowel. This may be impossible due to a bulky, diseased colon and a separate extraction site, often in the suprapubic region, would need to be considered.

If an anastomosis is to be performed, this can be performed using a circular stapler after the diseased segment of bowel has been exteriorized through an extraction site. A defunctioning ileostomy can then be considered in the right iliac fossa.

While technically possible and safe in expert hands, the decision to complete such operations laparoscopically must be taken by a senior clinician. Severe peritoneal soiling, difficult body habitus or patient instability would all be strong indications for conversion to an open procedure.

Other colorectal emergencies

Minimally invasive approaches to other colorectal emergencies have also been shown to be feasible, and has brought benefits such as shorter hospital stays, lower short-term mortality and earlier return of gut function.

A 2018 study published in the Annals looked at all patients who underwent an emergency colorectal resection for cancer within the NHS over a 6-year period, assessing over 15,000 patients. They found that laparoscopy use doubled from 15% in 2010 to 30% in 2016. Similarly, this paper showed a shorter length of stay (8 vs 12 days), and a lower 90-day mortality in the laparoscopic group.[14]

A 2014 systematic review in the British Journal of Surgery assessed 22 studies that looked at all emergency colorectal resections, comparing approximately 900 laparoscopic resections and 4500 open resections. The overall conversion rate was 3%, the most common reason being dense adhesions. Operating time in the minimally invasive group was longer (148 vs 184 minutes), but length of hospital stay was 5 days shorter (10 vs 5 days). Complication rates were also found to be significantly lower in the laparoscopic group.[15]

A comparison in IBD patients requiring subtotal colectomy and ileostomy showed no detriment to the laparoscopic group, and various series have shown the benefits of shorter hospital stays.[16] This seems logical given the significant use of steroids in this group of patients and the negative impact this has on wound healing. A cohort of 913 patients in the North of England who underwent emergency bowel resection for IBD highlights increasing utilization of laparoscopic surgery, by colorectal subspecialists. Although it should be noted that these changes did not correlate with improved surgical outcomes.[17]

Small bowel obstruction

Small bowel obstruction is one of the most common reasons for admission under a surgical take. The vast majority of admissions are due to adhesions from previous surgery. Approximately a quarter of patients require operation, with a laparoscopic approach to this becoming more common.

Given that relative contraindications to laparoscopy are abdominal distension due to bowel obstruction, and extensive previous surgery, it may seem illogical that a minimally invasive approach is taken.

At operation, however, often only a single adhesional band is found. This means that if access is obtained safely, and visualization of intra-abdominal structures is good, the band, or bands, may be divided safely. This will result in small incisions for the patients and all of the benefits that incurs.

There are, however, legitimate concerns regarding a minimally invasive approach given limited vision in the context of distended bowel, and the theoretical risk this may have for inadvertent small bowel injury. There are currently no surgical bodies that recommend a laparoscopic approach, and papers that describe it as feasible recommend it only for experienced surgeons.

A large 2017 retrospective population-based study in Canada published in the Annals compared the incidence of small bowel repair and resection following open and laparoscopic operations for small bowel obstruction over 10 years. Approximately 8500 patients were included, with nearly 700 patients having had a minimally invasive operation. Frequency of laparoscopic procedures increased from 4% to 14% in the 10 years.

The paper found a significantly higher rate of bowel repair and/or resection in the laparoscopic group. Despite this, laparoscopy was associated with significantly lower 30-day mortality, fewer postoperative complications and a shorter length of hospital stay.[18] Several other retrospective database analyses found these benefits to lesser degrees.

In the systematic review and meta-analysis by Krielen et al., the authors conclude that laparoscopic surgery is safe and feasible for adhesional small bowel obstruction.[19] Following evaluation of 14 studies, no significant differences were noted between open and laparoscopic procedures for postoperative mortality, iatrogenic bowel perforations, postoperative length of stay, postoperative complications and early readmission. However, laparoscopic surgery was noted to favour these outcomes over open surgery.

The potential for inadvertent injury to abdominal structures is significant and should be borne in mind when a decision is taken to offer minimally invasive surgery. The utilization of laparoscopy in small bowel obstruction remains equivocal. More works are required to help generate the consensus required to guide patient selection, whilst helping minimize intraoperative and postoperative risks.

Cholecystitis

Laparoscopic cholecystectomy is now the accepted standard for removal of a gallbladder. In a recent meta-analysis of 12 trials comparing laparoscopic and robotic cholecystectomy, greater operative times were associated with the robotic group, whilst similar safety and perioperative outcomes were noted.[20]

Complicated acute cholecystitis, resulting in gangrene or perforation, requires emergency cholecystectomy, and can be fatal unless treated. Perforation can be readily seen on CT, but gangrene can be harder to assess. Worsening or non-improving parameters or biochemical markers may be indicative of complicated cholecystitis.

Traditionally, in less severe cases, patients who had an attack of cholecystitis were treated supportively with antibiotics. Once the episode had settled, after a period of several weeks, a cholecystectomy was performed.

Increasingly, laparoscopic cholecystectomy is being performed in the acute setting, with surgery only being deferred for very complex cases, or for comorbid patients.

As a rule, cholecystectomy for acute cholecystitis in otherwise well patients should be performed as early as possible from the onset of symptoms – within 7 days. Local inflammation and formation of adhesions will occur after 72 hours of onset of symptoms making dissection more difficult, and operations more haemorrhagic.

A 2015 meta-analysis of 15 trials published in the British Journal of Surgery found that operations performed within 7 days of onset of symptoms resulted in fewer wound infections, shorter hospital stays and earlier return to work, despite longer operations. The paper found no increased likelihood of adverse complications, including bile duct injury.[21]

A significant number of patients presenting with acute cholecystitis will have an associated common bile duct stone. This may be identified during preoperative imaging or by on-table cholangiogram. Stones may be removed either by bile duct exploration (commonly performed laparoscopically) or by pre- or postoperative endoscopic retrograde cholangiopancreatography (ERCP).

If surgery is not possible within 10 days of onset, surgery should be deferred for 6 weeks to allow inflammation to subside. This is, of course, unless the patient's condition worsens. Intraoperative indocyanine green (ICG) fluorescence imaging may be utilized during surgery. Real time utilization of ICG can help delineate biliary anatomy better. There is a small evidence base concerning the use of ICG in emergency cholecystectomy; however, larger studies evaluating its practice do not exist.

Another benefit of offering early cholecystectomy is that a significant proportion of patients suffer from adverse events while waiting for their operation. These include further attacks of cholecystitis and pancreatitis. Indeed, in the case of gallstone pancreatitis, it is becoming the accepted standard of care that laparoscopic cholecystectomy is performed within the index admission.

In comorbid patients for whom surgery carries a significant risk, many surgeons advocate conservative treatment, and not to offer acute cholecystectomy. There are many techniques that can be used to treat complications from cholecystitis, for example a percutaneous cholecystostomy, but these are beyond the scope of this review.

Operative technique

After establishing a pneumoperitoneum, the supine patient is placed 'head up' with their left side tilted down. A common technique is for two 10-mm ports to be used (one at the umbilicus and one at the epigastrium), with two 5-mm ports being positioned under the right costal margin. The gallbladder is retracted superolaterally by the assistant, exposing the porta hepatis. It may be difficult to obtain purchase on an acutely inflamed or distended gallbladder. It may be helpful to aspirate the gallbladder with a sharp tipped suction device in these instances. Adhesions to the duodenum, omentum and colon are common and must be divided.

The next step is to obtain the critical view of safety, bounded by the gallbladder wall, cystic duct and common hepatic duct. This is best obtained by first demonstrating a large posterior window behind the gallbladder with subsequent dissection of the cystic artery and duct. Once convinced of the anatomy of all of the displayed structures, clips can be placed securely on the cystic duct and then artery, and then both structures divided (Figure 4). The gallbladder is then dissected from the gallbladder bed. If an on-table cholangiogram is to be performed, this should be done after the first clip has been placed distally on the cystic duct. Occasionally a safe view of Calot's triangle may not be possible due to extensive inflammation. In these cases, a subtotal cholecystectomy may be performed (Figure 5).

Herniae

Many case series and reports are available showing a wide range of acutely strangulated or incarcerated abdominal wall herniae having been tackled laparoscopically. In these cases, for example a femoral or obturator hernia, the hernia is reduced once

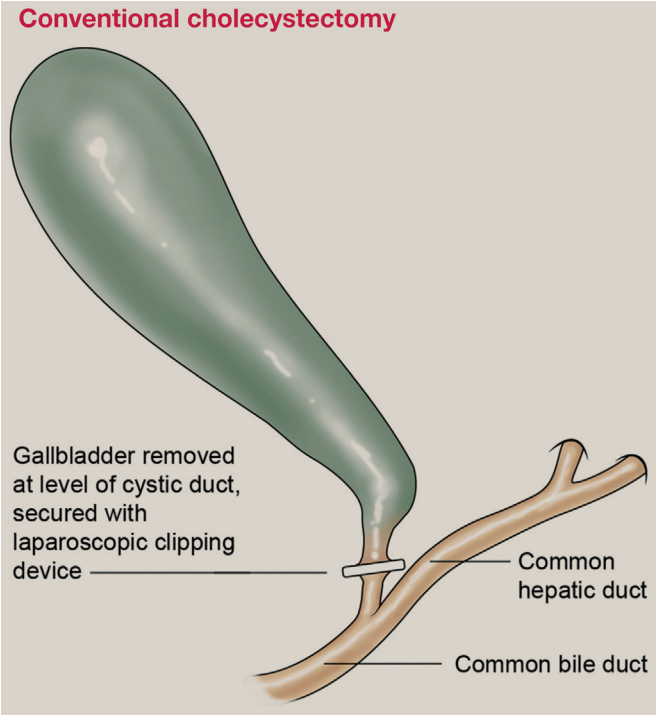

Figure 4

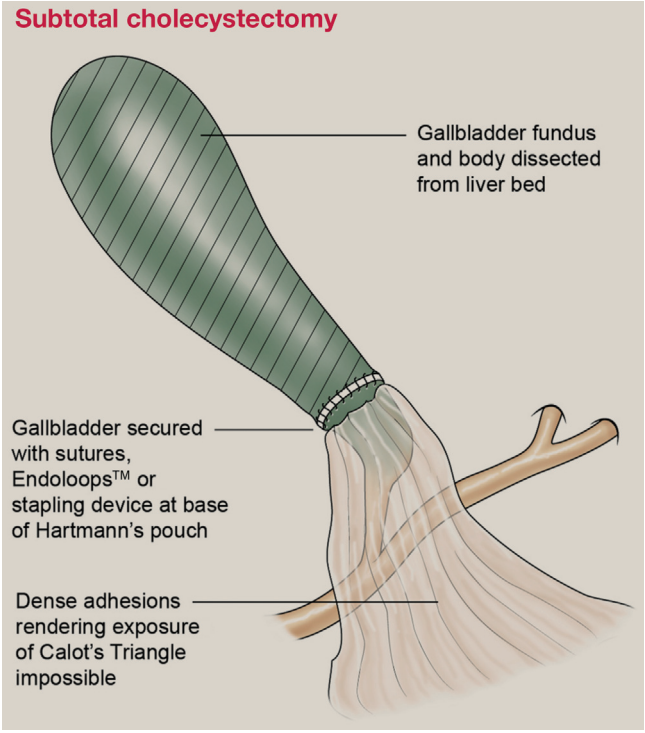

Figure 5

pneumoperitoneum is established. The contents of the hernia are then inspected — to assess, for example, whether a bowel resection is required. The sac is then reduced and a mesh appropriately placed to avoid recurrence. The same risks apply as for elective laparoscopic hernia repair. Given that a mesh will be placed in these operations, the surgeon must have a good clinical suspicion that bowel is not sufficiently compromised to render contamination likely. For these reasons, the default choice in acutely obstructed herniae remains an open operation.

With regard to diaphragmatic hernia, laparoscopic repairs in the acute setting are becoming more common. A 2016 paper assessing common practice concerning strangulated or incarcerated para-oesophageal herniae in the NHS found that no minimally invasive procedures were carried out prior to 2000. Over 30% were conducted using minimally invasive methods between 2009 and 2012.[22] It would be reasonable to assume this proportion has increased yet further, even though the mortality rate had not altered during the period of the study. Additionally, the paper showed that higher volume centres had lower 90-day mortality rates, pointing to the fact that centralization of complex upper gastrointestinal surgical services may have been of benefit.

In the systematic review by Peronne et al., in 2020, 49.5% of traumatic diaphragmatic herniae were managed laparoscopically. The authors conclude, "minimally invasive approach is safe and feasible, and offers advantages in terms of hospitalization and lower morbidity rate but is highly dependent on the surgeon's expertise, especially in the emergency setting."[23]

Given the lack of categorical supportive evidence, any decision to operate laparoscopically in the context of acute herniation must be taken at an appropriately senior level.

Conclusion

Minimally invasive surgery has revolutionized patient care within the elective setting, and its use continues to increase in the context of acute abdominal emergencies. Much scientific literature supports the use of laparoscopic surgery in a wide range of acute conditions, with patients suffering from appendicitis and cholecystitis appearing to benefit the most.

The use of laparoscopy in other settings has shown to be safe, but decisions to proceed using a minimally invasive technique must be taken at senior level by someone with adequate experience of the method. Failure to progress, inadvertent injury to abdominal viscera, or a deterioration in the physiological state of the patient warrants urgent consideration of conversion to an open operation. ◆

REFERENCES

1 Society of American Gastrointestinal and Endoscopic Surgeons. Guidelines for diagnostic laparoscopy, 2010.

2 Sauerland S, Jaschinski T, Neugebauer EAM. Laparoscopic versus open surgery for suspected appendicitis. *Cochrane Database Syst Rev*, 2010. Art. No.: CD001546. https://doi.org/10.1002/14651858.CD001546.pub3.

3 Matsevych O, Koto M, Balabyeki M, et al. Trauma laparoscopy: when to start and when to convert? *Surg Endosc* 2018; **32:** 1344–52.

4 Lunevicius R, Morkevicius M. Systematic review comparing laparoscopic and open repair for perforated peptic ulcer. *Br J Surg* 2005; **92:** 1195–207.

5 Lau H. Laparoscopic repair of perforated peptic ulcer: a meta-analysis. *Surg Endosc Other Inter Tech* 2004; **18:** 1013–21.

6 Zhou C, Wang W, Wang J, et al. An updated meta-analysis of laparoscopic versus open repair for perforated peptic ulcer. *Sci Rep* 2015; **5:** 1–13.

7 Sanabria A, Mi V, Mu Ch. Laparoscopic repair for perforated peptic ulcer disease (Review) summary of findings for the main comparison. 2013. Epub ahead of print. https://doi.org/10.1002/14651858.CD004778.pub3, www.cochranelibrary.com.

8 Schultz JK, Yaqub S, Wallon C, et al. Laparoscopic lavage vs primary resection for acute perforated diverticulitis: the SCANDIV randomized clinical trial. *JAMA - J Am Med Asso* 2015; **314:** 1364–75.

9 Vennix S, Musters GD, Mulder IM, et al. Laparoscopic peritoneal lavage or sigmoidectomy for perforated diverticulitis with purulent peritonitis: a multicentre, parallel-group, randomised, open-label trial. *Lancet* 2015; **386:** 1269–77.

10 Angenete E, Thornell A, Burcharth J, et al. Laparoscopic lavage is feasible and safe for the treatment of perforated diverticulitis with purulent peritonitis: the first results from the randomized controlled trial DILALA. *Ann Surg* 2016; **263:** 117–22.

11 Abraha I, Binda GA, Montedori A, et al. Laparoscopic versus open resection for sigmoid diverticulitis. *Cochrane Database Syst Rev*, 2017. Art. No.: CD009277. https://doi.org/10.1002/14651858.CD009277.pub2.

12 Halim H, Askari A, Nunn R, et al. Primary resection anastomosis versus Hartmann's procedure in Hinchey III and IV diverticulitis. *World J Emerg Surg* 2019; **14:** 1–8.

13 Cirocchi R, Fearnhead N, Vettoretto N, et al. The role of emergency laparoscopic colectomy for complicated sigmoid diverticulits: a systematic review and meta-analysis. *The Surgeon* 2019; **17:** 360–9.

14 Vallance AE, Keller DS, Hill J, et al. Role of emergency laparoscopic colectomy for colorectal cancer: A population-based study in England. *Ann Surg* 2019; **270**(1)**:** 172–9.

15 Harji DP, Griffiths B, Burke D, et al. Systematic review of emergency laparoscopic colorectal resection. *Br J Surg* 2014; **101:** 126–33.

16 Fowkes L, Krishna K, Menon A, et al. Laparoscopic emergency and elective surgery for ulcerative colitis. *Colorectal Dis* 2008; **10:** 373–8.

17 MacFarlane H, Baldock TE, McLean RC, et al. Patient outcomes following emergency bowel resection for inflammatory bowel disease and the impact of surgical subspecialisation in the north of England: a retrospective cohort study. *World J Surg* 2021; **45:** 1376–89.

18 Look Hong N, Byrne JP, Mason S, et al. Laparoscopic surgery for adhesive small bowel obstruction is associated with a higher risk of bowel injury. *Ann Surg* 2017; **266:** 489–98.

19 Krielen P, di Saverio S, ten Broek R, et al. Laparoscopic versus open approach for adhesive small bowel obstruction, a systematic review and meta-analysis of short term outcomes. *J Trauma Acute Care Surg* 2020; **88:** 866–74.

20 Huang Y, Chua TC, Maddern GJ, et al. Robotic cholecystectomy versus conventional laparoscopic cholecystectomy: a meta-analysis. *Surgery* 2017; **161:** 628–36.

21 Wu XD, Tian X, Liu MM, et al. Meta-analysis comparing early versus delayed laparoscopic cholecystectomy for acute cholecystitis. *Br J Surg* 2015; **102:** 1302–13.

22 Zaninotto G, Mackenzie H, Jamel S, et al. Practice patterns and outcomes after hospital admission with acute para-esophageal hernia in England. *Ann Surg* 2016; **264:** 854–61.

23 Perrone G, Giuffrida M, Annicchiarico A, et al. Complicated diaphragmatic hernia in emergency surgery: systematic review of the literature. *World J Surg* 2020; **44:** 4012–31.

Practice points

- Laparoscopic approaches to acute abdominal surgical emergencies have increased in recent decades.
- Minimally invasive surgery is associated with reduced postoperative pain and shorter hospital stays when compared with open surgery.
- Laparoscopic management of appendicitis and cholecystitis is recognized as first line treatment. Growing evidence suggests laparoscopy has an important role in the acute management of diverticulitis, peptic ulcer disease, herniae and small bowel obstruction.
- Laparoscopy in trauma patients has shown to be useful and may obviate the need for laparotomy.
- The decision to proceed laparoscopically in many acute abdominal emergencies remains a clinical one determined by a surgical team's experience and expertise.