



**LAPAROSCOPIC APPROACH TO ACUTE ABDOMEN
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)**

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Presented at the 19th International Congress of the European Association for
Endoscopic Surgery (EAES), Torino, Italy, June 2011



Abstract

Background: In January 2010, the SICE (Italian Society of Endoscopic Surgery), under the auspices of the EAES, decided to revisit the clinical recommendations for the role of laparoscopy in abdominal emergencies in adults, with the primary intent being to update the 2006 EAES indications and supplement the existing guidelines on specific diseases.

Methods: Other Italian Surgical Societies (ACOI, SIC, SICUT, SICOP) were invited in the Consensus forming a panel of 12 expert surgeons. A multidisciplinary panel is critical to achieve both guidelines and recommendations. Therefore Radiologists, Anesthesiologists, Gynaecologists, Epidemiologists, Nurses, Administrators, Health services researchers-managers and Care Regulators were also involved together with a patient's association. In November 2010 the panel met in Rome to discuss each chapter according to the Delphi method, producing a key statements with a grade of recommendations followed by a commentary to explain the rationale and the level of evidence behind the statements. Thereafter the statements were presented to the audience of the Annual congress of the EAES in June 2011

Results: A thorough literature review was necessary to assess whether the recommendations issued in 2006 are still current. In many cases new studies allowed us to better clarify some issues, but occasionally previous strong recommendations have to be challenged after review of recent research.

Conclusions: Every surgeon has generally developed a fine ability to decide the best approach according to a personal evaluation of her/his own experience, taking into account the clinical situation, her/his proficiency (and the experience of the team) with the various techniques and the specific organizational setting in which she/he is working. This guideline has been



developed bearing in mind that every surgeon could use the data reported to support her/his judgment.



Introduction

Acute abdominal pain, defined as any medium or severe abdominal pain with duration of less than 7 days, is a common presentation in surgical department, both in primary care and secondary referral hospitals.

Each year about 450 females and 180 males per 100.000 are hospitalized for acute abdominal pain, the most common causes being non-specific abdominal pain (15.9-28.1%), acute biliary disease (2.9-9.7%), followed by bowel obstruction or diverticulitis (¹).

In the last twenty years the role of laparoscopy in emergency surgery has increased continuously.

In 2006 the EAES published (²) its consensus statement on laparoscopy for abdominal emergencies, concluding that *“... available evidence clearly demonstrates the superiority of a laparoscopic approach in various emergency situations, but laparoscopy offers less and or unclear benefit in other acute conditions...Because the EAES updates its guidelines regularly, such data are also important before stronger recommendations can be issued. On the other hand, in those fields for which there is good evidence, laparoscopic surgery has been shown to be highly beneficial....”*

Almost five years have passed since the EAES guidelines publication, and in January 2010, the Scientific and Educational Committee of the SICE (Società Italiana di Chirurgia Endoscopica e nuove tecnologie - Italian Society of Endoscopic Surgery), affiliated with the EAES, decided to revisit the clinical recommendations for the role of laparoscopy in abdominal emergencies in adults, with the primary intent being to update the EAES indications and supplement the existing guidelines on specific diseases and to attain the following objectives:

1. establish the preferred diagnostic procedures, selection of patients – if applicable – and the suitability of the laparoscopic approach responsible for acute abdominal disease settings;
2. assess the indication, morbidity, duration of hospital stay, costs and recovery time from laparoscopic treatment for acute abdominal settings;
3. define the optimal practice in laparoscopy for each abdominal emergency and provide recommendations that reflect good practice.

For the purpose of the Consensus, we define an emergent case as the unplanned one with the need to proceed to surgery immediately (within several hours), once the decision has been made that surgical intervention is necessary or of potential benefit. Urgent case, on the other hand, as the one which can be performed in a timely manner, but there are cases in which delay until the next day or later is allowable and without undue risk to the patient.

Methods

Consensus Development: In order to better analyze the existing “evidence” on the subject, other Italian Surgical Societies¹ were invited to join the SICE in the Consensus forming a panel of 12 expert surgeons in emergency surgery – both laparoscopic and open. The involved scientific societies represented the entire Italian surgical community

The Consensus has been held under the Auspices of the EAES.

1 Associazione Chirurghi Ospedalieri Italiani (ACOI) – The Italian Society of Hospital Surgeons; Società Italiana di Chirurgia (SIC)- The Italian Society of Surgery; Società Italiana di Chirurgia d'Urgenza e del Trauma (SICUT)- The Italian Society of Trauma and Emergency Surgery and the Società Italiana di Chirurgia nell'Ospedalità Privata (SICOP) – The Italian Private Hospitals' Surgical Society.

Today it is generally agreed that a multidisciplinary panel is critical to achieve both guidelines and recommendations.

Therefore, besides Surgeons and the Promoting Committee, Radiologists (SIRM: Italian Society of Radiology), Anesthesiologists (SIAARTI: Italian Society of Anesthesia, Analgesia, Resuscitation and Intensive Care), Gynecologists (SIGO: Italian Society of Gynaecology and Obstetrics), Epidemiologists, Nurses (IPASVI: - the Italian National Federation Nursing Council), Health-services researchers, Hospital Administrators (Federsanità: Italian Federation of Local Health Districts and Municipalities), Health Managers (Società Italiana Medici Manager - SIMM - Italian Hospital Managers Society), Health Care Regulators (Istituto Superiore di Sanità - ISS - The Italian National Health Institute) were also involved. A patient's association was also invited and participated (Cittadinanzattiva Active Citizenship).

No pediatric surgeon was involved in the panel because only adult emergency surgery was taken into consideration.

For each disease previously analyzed by the EAES, three experts summarized independently the current state of the art, and their conclusions were made available to the entire panel. Ventral hernia surgery was added as a specific new topic and a paragraph on anesthesiologic considerations was also included.

In November 2010 the panel met in Rome for 2 days to discuss each chapter according to the Delphi method, producing a key statement with a grade of recommendations (GoR) followed by a commentary to explain the rationale and the level of evidence behind the statement. All key statements were formulated according to a 100% consensus obtained within the whole group. Next these statements were presented to the audience of the Annual congress of the EAES in June 2011 and then the draft document has been published on the web sites of all the involved Italian Surgical Societies for two months.



Comments both from the audience and from the web were collected and partly included in the manuscript as appropriate. The final version of the guidelines was approved by all the members of the panel.

Literature Searches and Appraisal: The Oxford hierarchy for grading clinical studies according to levels of evidence (LE) was used to facilitate comparison with the previous EAES consensus. The primary objective of the search was to identify all clinical relevant randomized controlled trials (RCT). However, other reports, population based outcomes studies, case series and case reports were also included. Studies containing severe methodological flaws were highlighted and downgraded as necessary. For each intervention, the validity and homogeneity of study results, effect sizes, safety and economic consequences were considered.

A systemic review based on comprehensive Literature research was made on Pubmed

Limits Activated: Humans, Clinical Trial, Meta-Analysis, Practice Guideline, Randomized Controlled Trial, Review, English, All Adult: 19+ years, published in the last 5 years.

Search details: [((("laparoscopy"[MeSH Terms] OR "laparoscopic"[All Fields]) AND ("condition-specific key word "[MeSH Terms] OR " condition-specific key word"[All Fields])) AND ("humans"[MeSH Terms] AND (Clinical Trial[ptyp] OR Meta-Analysis[ptyp] OR Practice Guideline[ptyp] OR Randomized Controlled Trial[ptyp] OR Review[ptyp])) AND English[lang] AND "adult"[MeSH Terms] AND "2005/1/1"[PDat]: "2010/11/25"[PDat])].

Limits regarding language, age, and publication date and study type were removed, and full texts from all the



abstracts were used based on specific criteria. The papers were selected and classified on the basis of highest level of evidence, design of the study, and most recent publication.

Cross-link control was performed with Google Scholar and Cochrane library databases.

According to the Health Technology Assessment Programme Manual (2001)³ clinical recommendations are defined as *“systemically developed statements to assist both the practitioner and patient decisions in specific circumstances...Guidelines are viewed as useful tools for making care more consistent and efficient and for closing the gap between what clinicians do and what scientific evidence support...”* We agree with what it is reported in the SIGN⁴ and SNLG⁵ manuals: *...clinical guidelines do not rob clinicians of their freedom, nor relieve them of their responsibility to make appropriate decisions based on their own experience and according to the particular circumstances of each patient. It is stressed that the standard of care required by Law derives from customary and accepted practice rather than from the imposition of practices through clinical guidelines...Guidelines are intended as an aid to clinical judgment not to replace it...”*

The Consensus development guidelines were reviewed in draft form by independent expert referees: Prof. Uraneus and Prof. Fingerhut for the EAES, and the methodology, by Professor Silvio Garattini for the Istituto Mario Negri – Italian Cochrane Center



Results

Acute cholecystitis

Patients with acute cholecystitis should be treated by laparoscopic cholecystectomy (GoR A). Severe (gangrenous, empyematous) cholecystitis and advanced age do not preclude the indication for laparoscopic cholecystectomy (GoR B). Surgery should be performed as soon as possible after the onset of symptoms (GoR A). Early laparoscopic surgery should be offered also to elderly patients (GoR B). In patients with severe co-morbidities, conservative treatment or percutaneous cholecystostomy, followed or not by early or delayed surgery, may be alternatives in order to reduce surgical or anesthesiological risks (GoR C).

Diagnosis of acute cholecystitis relies on a combination of local clinical signs, systemic signs of inflammation, and imaging findings. Very similar sets of criteria with almost 100% specificity have been suggested in the EAES guidelines of 2006 ⁽²⁾ and in the Tokyo Consensus Meeting Guidelines ⁽⁶⁾: both can be used in clinical practice.

The safety of laparoscopic cholecystectomy for acute cholecystitis has been shown in several studies. The EAES consensus statement published in 2006⁽²⁾ discussed the evidence from two randomized trials LE1b ^(7,8) and several comparative studies demonstrating faster recovery and shorter hospital stay in favor of laparoscopy. A recent USA population-based research outcome study, conducted over a six-year period (LE2c)⁽⁹⁾, indicated that laparoscopic cholecystectomy was associated with lower morbidity, lower mortality, and shorter hospital stays than open cholecystectomy.

However, it may be argued that the better outcomes of the laparoscopic cholecystectomy patients may be due to the medical



staff's attitude towards expectation of faster recovery rather than to true physiopathological changes (expectation bias). The only trial including a blind assessment of outcomes (by concealment of wounds both to patients and postoperative care staff) (8) showed very similar postoperative outcomes in both groups, but still demonstrated a shorter postoperative hospital stay for the laparoscopic group. Moreover recent randomized studies evaluated the influence of surgical trauma on systemic inflammation and immune response in acute cholecystitis demonstrated that a laparoscopic approach caused less surgical trauma and immunosuppression (LE1b)(10,11).

The question arises as to whether laparoscopic surgery is indicated for severe cholecystitis (gangrenous, empyematous or perforated). In a recent review of prospective and retrospective series (LE2a)(12), local postoperative complications were not found to be increase: laparoscopic cholecystectomy can be considered an acceptable indication for severe cholecystitis despite a threefold conversion rate. Subtotal cholecystectomy appears to be an acceptable alternative in patients with intense inflammation and increased risk of damage to Calot triangle structures (LE2a)(13).

Another subgroup that deserves a separate analysis is the elderly population. The number of elderly patients with acute cholecystitis has been increasing over the years and earlier reports suggested increased morbidity and a higher conversion rate for laparoscopic cholecystectomy in the elderly(14) and also increased morbidity. However it is very difficult to extrapolate data from series involving both acute and chronic gallbladder disease (15,16) or those comparing younger versus older patients (17,18) because acute biliary disease appears to be more severe in the older patients and the overall prevalence of co-morbidities is higher. Several prospective and retrospective comparative studies comparing laparoscopic versus open surgery for acute cholecystitis in elderly patients

suggested a reduction in the length of hospitalization (^{19,20,21}), with either unchanged (¹⁹) or improved morbidity (^{20,21,22})(LE2b).

The optimal timing of surgical intervention in acute cholecystitis is a major issue. Randomized controlled trials comparing early versus delayed open cholecystectomy have found that early surgery was associated with a lower complication rate and a shorter hospital stay (^{23,24,25,26}). However, earlier reports suggested an increased risk of conversion and intra-operative complications such as bile duct injury, if early treatment of acute cholecystitis was carried out by laparoscopic cholecystectomy (^{27,28}). Since the late 1990s, at least seven papers (^{29,30,31,32,33,34,35}) analyzed in 5 meta-analysis (LE1a) (^{36,37,38,39,40,41}) have been published. Six of those seven papers were RCTs (LE1b) but one of the systematic reviews (³⁸) included a non-randomized study (LE2b) (³⁴). One further RCT (LE1b) was not included in any systematic review because it was published at a later date(⁴²). The definition of time interval for early or delayed surgery varies among the studies taken into consideration: "early" ranged from 4 or 7 days after the onset of symptoms, while delayed treatment was defined as 6-12 weeks after index admission. In one of the studies (³²) the group of delayed treatment included patients operated on after resolution of symptoms, or within five days if the symptoms failed to resolve; those patients would have been included in the "early" group in the other trials; however, this study was not analyzed in three of the five systematic reviews. Despite these methodological issues, all studies reached the same conclusions: early treatment reduced total hospital stay and did not increase the complication or conversion rates (LE1a). 17.5% (range 13.9-25%) of patients included in the delayed surgery groups required urgent surgery during the interval period either after failure of conservative treatment or for recurrent symptoms after discharge. In this subset of patients the conversion rate was 45%. These data underscore the trend towards early surgery.



Despite the large number of studies addressing the issue of laparoscopic cholecystectomy in the elderly, only one retrospective trial examined the results of early versus delayed treatment in the aged and it found no statistically significant difference in outcome between the two groups ⁽⁴³⁾. A recent study examined a sample of the USA Medicare Claims Data System and found that 75% of patients aged 66 years and older, admitted as emergencies to an acute care facility for a first episode of acute cholecystitis, were treated by early cholecystectomy (71% laparoscopic and 29% open) ⁽⁴⁴⁾. The widespread use of early laparoscopic cholecystectomy in elderly patients, at least in the U.S.A., confirms that most surgeons are confident in performing early laparoscopic surgery for acute cholecystitis even in an aged population. Furthermore, the same outcome analysis showed that lack of definitive treatment during initial hospitalization in the elderly is associated with a 38% gallstone-related readmission rate over the subsequent two years (with only 9.5% of patient undergoing an elective outpatient cholecystectomy), compared with 4.4% in patients who underwent early treatment (LE2c).

Several alternatives have been proposed for emergency treatment in high risk septic patients unfit for emergency surgery: conservative treatment (LE1b)⁽⁴⁵⁾, tube cholecystostomy followed by early laparoscopic surgery (LE1b)⁽⁴⁶⁾, (LE4)⁽⁴⁷⁾, or by delayed open surgery (LE4)⁽⁴⁸⁾, and cholecystostomy alone (LE4)⁽⁴⁹⁾. A systematic review of 53 papers on cholecystostomy as an option in acute cholecystitis (LE2a) found no evidence to support the recommendation of percutaneous drainage rather than early emergency cholecystectomy even in critically ill patients, and actually suggested that cholecystectomy seems to be a better alternative for treating acute cholecystitis in the elderly and/or critically ill population ⁽⁵⁰⁾.



Two cost-utility analyses were published. One of them, performed in a prospective randomized trial, found no significant difference in the cost or outcomes of early laparoscopic cholecystectomy versus delayed treatment, with the latter favored by the incremental cost per additional Quality Adjusted Life Year (QALY); however patients operated on for biliary colic were included in the trial ⁽⁵¹⁾ (LE1b). A model-based economic evaluation to estimate costs and outcomes used data from a Cochrane review ⁽³⁹⁾ and showed that early surgery was less expensive and results in better quality of life than delayed treatment ⁽⁵²⁾(LE1b).

A randomized clinical trial of traditional dissection with electrocautery versus ultrasonic dissection demonstrated that operative time in laparoscopic cholecystectomy performed for acute cholecystitis was significantly shorter when ultrasonic dissection was used⁽⁵³⁾(LE1b). A prospective observational study confirmed this finding and showed a reduction in conversion rates for acute cholecystitis patients operated on laparoscopically with ultrasonic dissection⁽⁵⁴⁾(LE2b). A randomized trial on this topic is currently underway to clarify these observations⁽⁵⁵⁾.

We could not find any trial comparing results of conventional laparoscopic surgery versus single access surgery for acute cholecystitis. A randomized trial of early mini-laparoscopic versus conventional laparoscopic surgery did not find any statistically significant difference between the two techniques as concerns conversion rates, mean duration of the operation, hospital stay and major complications; however, the study was not based on intention to treat and the converted cases were excluded from the analysis⁽⁵⁶⁾ (LE2b).

Acute pancreatitis

In mild gallstone-associated acute pancreatitis, laparoscopic cholecystectomy should be performed as soon



as the patient has recovered and during the same hospital admission (GoR B). In severe gallstone-associated acute pancreatitis, laparoscopic cholecystectomy should be delayed until there is sufficient resolution of the inflammatory response and clinical recovery (GoR B). Apart from cases in which an emergency ERCP is indicated, in case of common bile duct stones, clearance should be obtained by preoperative ERCP or by laparoscopic removal of bile duct stones during cholecystectomy (GoR A). When pancreatic necrosis requires treatment for clinical signs of sepsis or multiorgan failure that do not improve despite optimal therapy, a step-up approach, consisting of percutaneous drainage, followed, if necessary, by minimally invasive retroperitoneal debridement, should be undertaken. Open surgery should be reserved to patients non-responding to minimally invasive treatment (GoR B). The abdominal compartment syndrome should be managed by prompt laparostomy or fasciotomy; laparoscopy is formally contraindicated in these cases (GoR C).

A number of guidelines have been published on the management of acute pancreatitis (AP), including those produced by the Italian Association for the Study of the Pancreas (⁵⁷). However, only the guidelines of European Association for Endoscopic Surgery, published in 2006, (²) specifically address the laparoscopic management of AP.

Acute pancreatitis is a frequent condition (^{58,59}), presenting with a wide spectrum of clinical features. Assessment of severity is mandatory, and it is usually performed by APACHE II score or CT scan (LE2b) (^{60, 61, 62}).

In gallstone pancreatitis, laparoscopic cholecystectomy is indicated to prevent disease recurrence. In mild pancreatitis, cholecystectomy should be considered as soon as the patient has



recovered and during the same hospital admission, while in severe pancreatitis cholecystectomy is delayed until there is sufficient resolution of the inflammatory response and clinical recovery (LE2b) (^{63, 64, 65, 62, 66, 67, 68, 69}).

When common bile duct (CBD) stones are suspected, confirmation with endoscopic ultrasonography (EUS) or magnetic resonance cholangiography (MR) should be obtained whenever possible (^{70,71}). EUS or MR allow detection of CBD stones with sensitivity and specificity both of over 90%, avoiding unnecessary bile duct exploration (⁷²). If the diagnosis of CBD stones is confirmed, it can be managed either by preoperative ERCP (⁷³), laparoscopic CBD clearance during cholecystectomy (laparoscopic or combined laparo-endoscopic “rendez-vous”) (^{74,75}) or at the next best opportunity. Two meta-analyses showed no differences when preoperative ERCP was compared to intraoperative removal of CBD stones (^{76,77}) (LE1b). The choice of treatment should be determined by local expertise, since laparoscopic CBD exploration requires substantial surgical skills.

Radiological drainage and/or surgery are indicated to treat infected pancreatic necrosis with clinical signs of sepsis, and sterile pancreatic necrosis with multiorgan failure that do not improve despite maximal therapy (⁵⁷). The treatment of necrosis should be delayed by at least 14 days from the onset of pancreatitis (^{57,78}). When surgery is indicated, traditional necrosectomy through laparotomy can be performed, but less invasive approaches have recently been gaining surgical attention. Laparoscopic debridement can be performed through an infracolic (⁷⁹) or retroperitoneal approach (^{80,81}); transgastric endoscopic pancreatic necrosectomy has also been reported (⁸²). Two recent prospective studies (one single-arm (⁸³) and one randomized (⁸⁴)) suggested that the presence of a well-demarcated necrosis can be treated using a step-up approach whenever possible (LE 1b). The first step should be percutaneous drainage, followed, whenever, by minimal invasive

retroperitoneal debridement. Open surgery should be the last step, to be performed in cases where more conservative treatment has failed. This strategy has been associated with a significantly lower morbidity (diabetes, incisional hernias) and lower new-onset multiple organ failure when compared to open surgery as the first step (⁸⁴).

The only indication for early surgery in acute pancreatitis is the presence of a compartment syndrome (^{85, 86, 87}), which should be managed by surgical decompression (laparostomy or fasciotomy) (LE 4); laparoscopy is formally contraindicated in these cases.

Acute appendicitis

Patients with symptoms and diagnostic findings suggestive of acute appendicitis should undergo diagnostic laparoscopy (GoRA) and, if the diagnosis is confirmed, laparoscopic appendectomy (GoRA).

More than 25 years after the first laparoscopic appendectomy (LA)⁽⁸⁸⁾ technical aspects and outcomes are still debated, despite recent guidelines^(89,90). Preoperative ultrasound study in addition to clinical examination and CT in equivocal cases (LE 2b), seem to lower the negative appendectomy rate and missed perforations^(91,92). LA can be considered the gold standard in pre-menopausal women (LE 1a)⁽⁹³⁾, and it is feasible in the elderly (LE 3)⁽⁹⁴⁾, the obese (LE 3)⁽⁹⁵⁾, but in men no advantages have been shown compared with open appendectomy (OA)(LE 1b)⁽⁹⁶⁾. Complicated appendicitis can be approached laparoscopically, with significant improvement of the surgical site (SS) infection rate (minor advantage according to Clavien's criteria)(LE 3a)^(97,98). Thorough peritoneal lavage (>6-8 liters) and aspiration is recommended in complicated appendicitis (LE 5) in order to minimize abscess formation rate⁽⁹⁹⁾. The reported increase in post-operative intraabdominal abscesses⁽⁹³⁾ is probably

due to initial experiences and has not been confirmed by more recent reviews (LE 2a)⁽¹⁰⁰⁾. Despite evidence that considers LA safe in pregnancy⁽¹⁰¹⁾, advantages are minor (less pain, less infections, less early deliveries) when compared to the risk of fetal loss, which seems greater than with OA (LE 2) ⁽¹⁰²⁾. Removal of a normal appendix in the presence of other diseases at exploration is not recommended. If no other disease is encountered and the appendix appears “normal”:

1. Remove the appendix if there is preoperative history of appendicular colicky pains and pre-op exams (US or CT) reveal suspected faecalith or fecal impaction in the appendix (LE 4)⁽¹⁰³⁾;
2. Morbidity of appendectomy does not significantly exceed that of the explorative laparoscopy. If the practice's rate of abscesses is minimal, then appendectomy is advised in order to prevent recurrent pain and readmission (up to 13% and 9%) and to gain the “endoappendicitis”, which account for 11-26% of normal appendices at pathologic examination (LE 5)⁽¹⁰⁴⁾.

Regarding appendiceal stump closure, stapling has been found to reduce operative time and superficial wound infections (LE 1a)⁽¹⁰⁵⁾, but since there is no evidence to prove a lower rate of deep abscess with the use of staplers, higher costs may influence the choice toward loop-closure. Cochrane protocol results (stapler vs. loop, primary outcome deep abscess rate) are awaited ⁽¹⁰⁶⁾, nevertheless attention must be paid to training results in the two methods apart from comparative costs; in fact LA is mostly performed by young and less experienced surgeons during late afternoon or nighttime, therefore an easier and technically standardized method such as the mechanical stapler might prove to be advantageous (LE 5) (90).

Three port appendectomy is still the laparoscopic gold standard. Various trocar sites and sizes can be used: in young women umbilical and two suprapubic trocars has been suggested to provide better cosmetic results (LE 5) ⁽¹⁰⁷⁾. Needlescopy should be applied only in selected and non complicated cases due to its higher

rate of conversions and prolonged operating room time (LE 1a)⁽¹⁰⁸⁾. Trocar incisions should follow Langer's lines to achieve better cosmetic results (LE 5)⁽¹⁰⁹⁾. Single port appendectomy is still inferior to the standard three port technique (LE 3b)⁽¹¹⁰⁾. NOTES appendectomy (via natural orifices) is admitted only in strictly controlled clinical and experimental protocols⁽¹¹¹⁾. Fast track procedures in the post-op care of LA should be studied and implemented (LE 5)⁽¹¹²⁾. Costs should not be the determining factor in favouring open or LA, unless there is a routine application of costly technology, due to the surgeons' choice (LE 2a)^(113,114). The panel believes that standardization of the technique is of utmost importance to improve the quality of future trials regarding LA and also for teaching and training purposes (LE 5)^(89,115).



Gynaecologic disorders

When gynaecologic disorders are the suspected cause of abdominal pain, diagnostic laparoscopy should follow conventional diagnostic investigations, especially US (GoR A), and, if needed, a laparoscopic therapy for the disease should be performed (GoR A).

A close cooperation with the gynaecologist is strongly recommended (GoR A). Diagnostic laparoscopy should follow other non-invasive diagnostic investigations in ectopic pregnancy (GoR B), adnexal torsion (GoR C), pelvic inflammatory disease (GoR B) and haemorrhagic ovarian cysts (GoR D). In endometriosis diagnostic laparoscopy can be considered the gold standard as diagnostic investigation (GoR A).

Laparoscopic therapy should be performed in ectopic pregnancy (GoR A), adnexal torsion (GoR A), endometriosis (GoR A) and haemorrhagic ovarian cysts (GoR B). Other less invasive procedures should be performed in pelvic inflammatory disease (GoR A).

The recommendation of close cooperation with the gynaecologist in the setting wherever available in the field of gynaecological emergencies was reported in the previous EAES Guidelines without any further supportive evidence.

The most common diagnoses encountered in female patients with acute lower abdominal and/or pelvic pain are ⁽¹¹⁶⁾: ectopic pregnancy (EP), adnexal torsion (AT), endometriosis, pelvic inflammatory disease (PID) and haemorrhagic ovarian cysts. Many acute gynaecological diseases can be approached safely and effectively by laparoscopy with the aim not only to correctly diagnose the diseases, but also to treat them (LE 4) ^(117, 118, 119, 120, 121, 122, 123, 124, 125, 126, 127, 128).

In gynaecological emergencies, transvaginal and conventional ultrasound (US) with the aid of a pregnancy test can formulate a differential diagnosis in a high percentage of patients (LE 3b)⁽¹²⁹⁾. CT and MR scans are very rarely useful (LE 2b)^(130, 131, 132,133). However, diagnostic laparoscopy (DL) is better than US (LE 2b)^(134, 119, 117, 123, 125, 128) and may lead to the modification of an incorrect preoperative diagnosis in up to 40% of cases (LE 4)^(135, 119, 123, 125, 136). Early DL results in the accurate, prompt, and efficient management of acute abdominal pain particularly in general practice, where it reduces the rate of unnecessary laparotomy and right iliac fossa gridiron incisions and increases the diagnostic accuracy (LE 4) ^{(117, 118, 120, 121,}

¹²²). In particular DL has been shown to reduce the risk of a negative appendectomy when appendicitis is suspected, with a stronger effect in fertile women, mainly due to the correct diagnosis of gynaecological disorders (LE 1a)^(137,138).

Ectopic pregnancy (EP) is a potentially life-threatening condition. Approximately 1/100 pregnancies are ectopic, with the embryo usually implanted in the fallopian tube. Some EPs resolve spontaneously, but others continue to grow and lead to rupture of the tube. Risks are higher in women with damage to the fallopian tubes due to pelvic infections, surgery, or previous EP⁽¹³⁹⁾. In women in early pregnancy presenting with acute pelvic pain and/or vaginal bleeding, a diagnosis of EP should always be considered. Current diagnosis of tubal EP involves a combination of transvaginal US and measurement of serum human chorionic gonadotropin (hCG) concentrations. In the vast majority of cases, a pregnancy test can exclude the diagnosis in cases with only minor symptoms. However, accurate and early ascertainment remains problematic, and there are often delays in making the diagnosis and implementing treatment. Further difficulties are encountered because serial hCG determination cannot accurately distinguish arrested intra-uterine-pregnancy from tubal EP. Although laparoscopy can be required occasionally to confirm the diagnosis of EP, we emphasize that this procedure that is not without risk. On the other hand in women in early pregnancy presenting with acute pelvic pain and/or vaginal bleeding with inconclusive diagnosis of EP after hCG concentrations and US, a diagnostic laparoscopy can be considered to exclude EP (LE 5) ^(128,140)).

In the management of tubal EP there are three options: surgery, medical treatment and expectant management. These options should be evaluated in terms of treatment success (i.e. complete elimination of trophoblastic tissue), financial costs and



future fertility. Laparoscopic salpingectomy should be performed in cases of ruptured tubal EP. In cases of unruptured tubal EP, a tube-preserving operation (laparoscopic salpingostomy) should be considered. Hemodynamic instability is a contraindication for laparoscopy. In EP an alternative non surgical treatment option in selected patients with low serum hCG concentrations is medical treatment with systemic methotrexate (MTX). Expectant management cannot be adequately evaluated yet (LE 1a)^(141, 142, 143, 139). In particular, in patients with EP, laparoscopic surgery should be undertaken because its total cost is less (LE 1b)⁽¹⁴⁴⁾. It is fast, and fertility outcome is comparable to laparotomy. Furthermore, sick leave and hospitalization are shorter and adhesion development is minor compared to laparotomy (LE 1b)^(145, 146, 147, 148, 149).

The diagnosis of **adnexal torsion (AT)** is missed in half of the cases. After excluding pregnancy, a transvaginal US is mandatory to exclude ovarian cyst formation. In cases with persistent pain and/or if a larger cyst is seen on ultrasound, a diagnostic laparoscopy may be performed to exclude AT (LE5)⁽¹²⁸⁾. When AT, an organ-threatening disease, is suspected, urgent surgical intervention is indicated. Despite the “necrotic” appearance of the twisted ischemic ovary, detorsion is the only procedure which should be performed at surgery. Adnexectomy should be avoided as ovarian function is preserved in 88% to 100% of cases⁽¹⁵⁰⁾. The laparoscopy procedure for ovarian conservation is recommended to treat patients with AT owing to its shorter hospital stay, fewer postoperative complications and ovarian preservation. (LE 2b)^(151, 152,153). When ovarian cysts are found during diagnostic laparoscopic, they should be treated laparoscopically (LE 1a)^(154, 155,156). Laparoscopic surgery was also reported to be superior compared to open surgery for resecting other types of ovarian cysts (LE 1b)⁽¹⁵⁷⁾.



Endometriosis can cause dysmenorrhoea, dyspareunia, non-cyclic pelvic pain and subfertility. The estimated prevalence of endometriosis in the general population is 1.5% to 6.2%, but in women with dysmenorrhoea, the incidence of endometriosis is 40% to 60%, and in those with subfertility it is 20% to 30%⁽¹⁵⁸⁾.

Symptoms and laparoscopic appearance do not always correlate. Pain is usually chronic and recurrent, but some patients present with acute symptoms (158). In comparison with the histopathology, laparoscopy alone showed 97.7% sensitivity, 79.2% specificity, 72% positive predictive value and 98.4% negative predictive value. (LE 2b)⁽¹⁵⁹⁾. Surgical treatment may be indicated in some patients and may be performed as an open procedure or laparoscopically, although no trials have compared the two approaches (LE 5)⁽¹⁶⁰⁾. More evidence is available on the comparative effectiveness of laparoscopic excision versus conservative treatment of endometriosis. Although these studies included elective rather than emergency patients, their results indicate that laparoscopic excision results in clear and patient-relevant advantages as opposed to conservative treatment (LE 1a) ^(161, 162, 163).

Pelvic Inflammatory Disease (PID) describes the clinical features of sexually transmitted pelvic infection ranging from acute salpingitis to salpingo-oophoritis and ultimately tubo-ovarian or pelvic abscess, which may lead to both sub-fertility and tubal EP.

Laparoscopy has demonstrated that PID is the cause of non-specific-abdominal-pain (NSAP) in young women in 13% of patients (LE 1b)⁽¹⁶⁴⁾. Laparoscopy can be considered the definitive diagnostic modality and is useful to exclude other pathologies, which may be present in approximately 20% of patients (LE 4)⁽¹⁶⁵⁾ but we underscore that this invasive procedure is not suitable for routine clinical practice especially in the primary care setting. Microbiological specimens should be taken to guide antibiotic therapy (LE 3b)⁽¹⁶⁶⁾.

In women of reproductive age tubo-ovarian abscess is one of the most common types of pelvic abscess. Tubo-ovarian abscesses are classically treated with broad-spectrum antibiotics. In about 25% of the cases this approach fails and surgical intervention becomes



necessary. Surgical procedures include laparotomy or laparoscopy with drainage of the abscess, unilateral or bilateral salpingo-oophorectomy, and hysterectomy. However, surgery for tuboovarian abscess is often technically difficult and associated with complications (LE 4) ^(167,168). An alternative approach is the use of imaging guided drainage of the abscess in combination with antibiotics: RCT indicates that ultrasound-guided transvaginal drainage with concomitant antibiotics is especially safe and efficacious (LE 1b)⁽¹⁶⁹⁾. Depending on the severity of symptoms, laparoscopy is therefore considered to be advantageous in selected cases of acute salpingitis (LE 4) ^(165, 170) and tubo-ovarian abscess (LE 4) ⁽¹⁷¹⁾.

Initial management of a suspected follicular or haemorrhagic cyst is supportive management and continued observation with a repeat pelvic ultrasound in approximately 4 to 6 weeks to document resolution. Indications for immediate operative intervention include a large amount of peritoneal fluid found on a transvaginal ultrasound, hemodynamic instability, and severe pain. Delayed operative management is indicated for patients in whom pain does not improve with conservative management or for persistent tumors to rule out a neoplastic process. A cystectomy is recommended as opposed to a unilateral salpingo-oophorectomy in reproductive-aged women. Laparoscopic evaluation is usually feasible; however, if cancer is suspected, laparotomy may be necessary to ensure complete removal and for staging purposes (LE 5) ⁽¹¹⁶⁾. Laparoscopic surgery advantages over laparotomy include shorter hospital stay without increased adverse events (LE 2b) ⁽¹⁷²⁾.

Nonspecific abdominal pain

Diagnostic laparoscopy is technically feasible and can be applied safely for selected patients with acute nonspecific abdominal pain after a complete diagnostic work-up (GoR A).



Nonspecific acute abdominal pain (NSAP) is defined as acute abdominal pain lasting less than 7 days and for which diagnosis remains uncertain after baseline examination and diagnostic tests ⁽¹⁷³⁾.

Although attempts have been made towards developing consensus guidelines and diagnostic algorithms, no evidence-based clinical guidelines about NSAP have been developed or validated to date ^(174,175).

Recently, enhanced or non-enhanced computed tomography of the abdomen and pelvis has been proposed as a particularly useful adjunct in the initial assessment of patients with NSAP ^(176,177) (LE 1a)

Several studies have documented the feasibility and safety of diagnostic laparoscopy (DL) under general anaesthesia for patients with acute abdominal pain ^(178,179) (LE 1a)

The diagnostic accuracy of the procedure is high, ranging between 90 and 100% (LE 2a) and prevents unnecessary laparotomies in 36-95% of patients in the published series ⁽¹⁸⁰⁾ (LE 3b)

Overall morbidity, also in ICU patients, has been reported between 0% and 8% in expert hands, and no mortality directly associated with the procedure has been reported ^(181,182) (LE 2b).

Contraindications for DL do not differ from contraindications to exploratory laparotomy ⁽¹⁸⁰⁾.

The role of early laparoscopy compared with the traditional “wait and see” in the management of NSAP in patients with unclear diagnosis after baseline examinations and tests, has been evaluated by randomized controlled trials ^(183, 184, 164) with controversial results due to small sample size, or absence of long term follow-up.

DL seems to improve the diagnosis rate (81-97% versus 28-36% in observational group) and subsequent treatment of patients with NSAP leads to reduced hospital stays (LE 2b) but two controlled



trials have failed to show that DL is useful in prevention of recurrence of symptoms (LE 1b) ^(164,185)

The available literature has a number of limitations including the lack of homogeneity in the reported patient populations and the frequent absence of high-quality preoperative imaging studies, which may have provided the diagnosis without the need for an invasive procedure. Furthermore, better-quality research is needed to evaluate the definitive role of DL in patients with acute NSAP.

Perforated peptic ulcer

Diagnostic laparoscopy is a useful tool when preoperative diagnostic findings are not conclusive especially if performed with therapeutic intention (GoR A). Laparoscopy is a possible alternative to open surgery in the treatment of perforated peptic ulcer (GoR B).

The diagnosis of a perforated peptic ulcer (PPU) is based on clinical history, on clinical examination and on instrumental investigations. A CT scan of the abdomen represents the most reliable exam not only for the diagnosis of perforation (sensitivity nearly 100% for the detection of pneumoperitoneum), but also to identify the perforation site (specificity approximately 86%) ^(186,187,188) (LE 2b). A diagnostic laparoscopy is possible when preoperative exams are not sufficiently clear for definite diagnosis (LE 1a) ^(189, 190, 118). However, failing to identify PPU represents one of the most frequent causes of conversion to laparotomy ⁽¹⁹¹⁾ (LE 1a).

To date, there is no unanimous agreement about which group of patients might benefit from a laparoscopic approach of PPU. Several studies suggest that Boey's shock-score on admission (blood pressure BP < 90mmHg), ASA III-V (severe co-morbidities), duration of symptomatology (>24 h) ^(192, 193) is the most reliable for selecting patients: (LE 3b). Laparoscopic approach is safe in patients with no risk factors (Boey score=0) ⁽¹⁸⁹⁾ (LE 1a). Other principles of



selection have been considered: MPI (Mannheim Peritonitis Index ⁽¹⁹⁴⁾ (LE 2b), age > 70 years ⁽¹⁹³⁾ (LE 3b), APACHE II⁽¹⁹⁵⁾ (LE3b) and “surgeon’s skill in mini-invasive surgery”

The choice of perforation closure technique depends on lesion characteristics: if margins are edematous, friable and or difficult to mobilize, repair can be performed using only an omental patch ⁽¹⁹⁶⁾ (LE 5); when the margins can be easily brought together, without tension, direct suturing can be sufficient with or without omentoplasty ⁽¹⁹⁷⁾ (LE 3a). To make the PPU repair simpler, and consequently reducing operating times, a “sutureless” technique has been proposed ⁽¹⁹⁶⁾. However debate exists whether the reduction of operating times by simplified techniques could be a patient safety issue, with a higher incidence of post-operative complications (especially of leakage) (LE 5).

Decontamination of the peritoneal cavity by washing after treatment of PPU represents a fundamental step of the surgical procedure (LE 1a) ⁽¹⁹⁷⁾.

Predictive factors of conversion are: shock on admittance and the free interval between the beginning of perforation and the diagnosis >24 h ^(198, 199, 200) (LE 2b).

In Lau’s meta-analysis¹⁹¹ the re-operation rate was higher after the laparoscopic approach (3.7%) than with conventional surgery (1.6%) (LE 1a). Suture site leakage represents the most important cause of re-operation (LE 1a). Lee APACHE II (5 points) and ulcer size (> 10 mm) are independent risk factors for postoperative leak for laparoscopic sutureless fibrin glue repair ⁽¹⁹⁵⁾ (LE3b). A systematic review by Lunevicius ⁽¹⁸⁹⁾ reported a re-operation rate nearly double that for open surgery (5.3% vs. 2.1%). The results of these studies, due to many biases, are not enough to definitively clarify the role of the laparoscopic repair for PPU. Further trials are needed.

One of the advantages of laparoscopic surgery is less post-operative pain ^(189, 196, 201) (LE 1a), but others experiences ⁽¹⁹⁶⁾ of



earlier data about pain (within 24 h of p.o. time) did not show any difference, probably due to peritoneal phlogosis. Recent literature reports confirm a decrease in the incidence of complications in laparoscopic surgery compared to open surgery (abdominal wall complications, prolonged post-operative ileus, pulmonary infection and reduction of mortality rate) ⁽¹⁹⁷⁾. On the other hand a higher incidence of intra-abdominal fluid collection (mostly due to leakage of the suture site) has been reported ⁽¹⁹⁷⁾. However none of these differences are statistically significant ⁽¹⁹⁷⁾. The operative times are longer for laparoscopy ^(196, 202) (LE1b) (except one study) ⁽¹⁹⁰⁾, however, a progressive and constant reduction of operative times over the past ten years has been shown, probably due to an improvement in the surgeon's skill, better technology and better organization of the surgical teams. The hospital stay has shown to be more favorable for the laparoscopic approach compared to traditional surgery in Siu ⁽¹⁹⁰⁾ but not in Lau ⁽¹⁹⁶⁾ and Bertleff ⁽²⁰²⁾.

Acute diverticulitis

Laparoscopic approach with lavage and drainage is indicated in complicated diverticulitis Hinchey I and IIa (when percutaneous drainage failed and when indicated for clinical deterioration) and Hinchey IIb and III (GoR B). In Hinchey IV diverticulitis, as well as Hinchey III when lavage and drainage is not advised, a colonic resection may be indicated, with or without diverting protection stoma, which may be performed laparoscopically, depending on the general conditions of the patient and on the skill of the operator (GoR C).

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 to undergo emergency surgery (LE 2a) ^(203, 204). Following recovery, a study of the colon should be performed, to evaluate the extension of diverticular disease and to rule out alternative diagnoses such as ischemic colitis, inflammatory disease or colonic cancer. Optical colonoscopy, barium enema and CT colography (the so-called virtual colonoscopy) may all be employed, but the latter provides data about the bowel and the surrounding tissues and organs as well. When elective sigmoid resection is indicated, laparoscopy treatment is associated with a reduction in postoperative pain, systemic analgesia requirements, hospital stay, overall postoperative morbidity and total hospital cost and finally improves quality of life (LE 2b) ^(205, 206, 207, 208, 209, 210, 211, 212, 213).

Complicated cases of diverticular disease are classified according to the modified Hinchey classification. Stage I indicates the presence of a pericolic abscess, stage IIa indicates distant abscess amenable to percutaneous drainage, stage IIb indicates complex abscess with or without fistula. Diffuse peritonitis is classified as stage III (purulent), or stage IV (fecal) ^(214, 215, 216).

In stages Hinchey I and IIa, percutaneous drainage usually is effective in controlling symptoms ⁽²¹⁷⁾, although in most cases simple medical therapy could be equally effective ^(218, 219). Abscess size and location influence the likelihood of response to percutaneous therapy. In patients with septic signs after drainage and in those with Hinchey IIb and Hinchey III, surgical treatment is indicated. In those cases, laparoscopic lavage is possible, with the aim to potentially spare the patient from both a major bowel resection and stoma creation (LE 2b) ^(220, 221); abundant lavage of the peritoneal cavity and positioning of multiple (at least 2) drainages is indicated. The search for the perforation should not be pursued at all costs; when a large leak is spontaneously evident, a fecal fistula is usually present or will appear after the operation, and the patient should be

managed as an Hinchey IV case (LE 5) (^{222, 223}). However, if a small colonic perforation is shown 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 operator (LE 5) (^{224, 225}).

This strategy, which aims to convert generalized purulent peritonitis to localized diverticulitis which can be safely treated by 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 (with particular reference to SS complications such as dehiscence, SS infection, and incisional hernia) (LE 3a) (^{226, 227, 228, 229, 230, 231, 232, 233, 234}). After peritoneal lavage and drainage, elective colonic resection can be planned within 3-6 months, but some authors actually propose to limit treatment to simple peritoneal lavage and not to proceed to sigmoid resection. More than 50% of patients in the reported series did not need subsequent sigmoidectomy; up to 90 out of 92 cases in the Irish prospective multicentric study, which followed the patients for a mean of 36 months (range 12-84 months) (LE 2B) (²³⁵).

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 (^{226, 227, 229}), or should undergo emergency colonic resection by laparoscopy but only if performed by experienced hands (LE 3b) (^{236, 237, 238}). Of note, elective resection of the diseased segment decreases the risk of conversion and increases the rate of primary anastomosis, when compared to emergency surgery (LE 5). In stage Hinchey IV, colonic resection can be performed by laparoscopy or by open surgery, depending on the skill of the operator and the clinical stability of the patient, even if

the evidence is still too weak for a specific recommendation (LE 3b) (^{239, 240}, 212).

Small bowel obstruction due to adhesions

Laparoscopic treatment of small bowel obstruction can be successfully accomplished in selected patients (GoRC).

Adhesions represent the leading cause of small bowel obstruction (SBO), accounting for about 75% of all SBO. The first reports of laparoscopic treatment date from the early 90's (²⁴¹). Surgery does not influence the risk of recurrence nor the need for a future operation (^{242, 243})(LE 2b). Duron et al. (²⁴⁴) suggested that the rate of primary or secondary recurrence (12 and 18% respectively) were not different after open compared to laparoscopic surgery (LE 2b). Neither RCTs nor prospective controlled studies are available in the scientific literature. (²⁴⁵)

An animal experimental study showed that laparoscopy decreased the incidence, extension and strength of intraperitoneal adhesions compared with laparotomy (²⁴⁶). A retrospective cohort of 716 consecutive patients undergoing either laparoscopic (211 pt) or open bowel resection (505 pt) suggested that postoperative SBO requiring hospitalization with conservative management was reduced in those patients who had laparoscopic surgery (n = 4) compared to the open surgery cases (n = 31) (p < 0.016)(²⁴⁷) (LE). The main concern is the high conversion rate: complete laparoscopic treatment has been reported possible in only 50%-60% of patients. Papers published after 2005 have showed a trend toward a reduction in conversion rate, in the laparoscopically treated patients, constantly lower than 50% (^{248, 249, 250, 251, 252, 253, 254, 255, 256, 257}) (LE 3b).

Guidelines concerning laparoscopy and SBO published after the EAES consensus statements are controversial. The EAST



guidelines for the management of bowel obstruction ⁽²⁵⁸⁾ suggest that the laparoscopic treatment of SBO can be considered and leads to a shorter hospital length of stay in a highly selected group of patients (LE 2). Notwithstanding, laparoscopy was not included in the suggested flow chart.

The SAGES guidelines on diagnostic laparoscopy consider that laparoscopy is contraindicated in patients with a clear indication for surgical intervention such as massive bowel obstruction, perforated viscus (free air), besides those with hemodynamic instability ⁽²⁵⁹⁾.

A systematic review including 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%. Positive predictive factors for success are less than 2 previous laparotomies and absence of peritonitis. ⁽²⁶⁰⁾ (LE 2b)

Laparoscopy should not be used for diagnosis of SBO, but it should be preceded by conventional imaging, in order to reduce the risk of iatrogenic injuries without therapeutic purposes. In some studies the following criteria were found to be statistically significant for failure of the laparoscopic approach: small bowel loop diameter > 4 cm, more than two previous abdominal operations (LE 2B), operation after 24 hrs from diagnosis, duration of surgery, and dense and extensive adhesions. Previous appendectomy was statistically associated with a higher rate of successful laparoscopic management, with the single band adhesion as the ideal condition for the laparoscopic approach (LE 3B) ^(2, 261, 262, 263, 264, 265).

The use of a tailored laparotomy (i.e. incision according to exploratory laparoscopy findings) would be a potential benefit of the laparoscopic approach but this has not yet been demonstrated ^(2, 246, 247, 248, 250). Successful laparoscopic treatments of patients with negative predictive criteria are described without complication in some papers. A low threshold for conversion to traditional surgery is recommended (LE 5).



Incarcerated/strangulated hernias

The laparoscopic technique for the treatment of non reducible or strangulated inguinal hernias, whether TEP or TAPP, may be performed (GoR B). The laparoscopic repair of non-inguinal incarcerated hernias (diaphragmatic, either congenital or acquired, supra-vescical or spigelian, obturatorian, and internal hernias) may be performed, but further studies are necessary to validate this approach (GoR D).

In the natural history of inguinal hernia, 0.29-2.9% of cases become incarcerated; 10-15% of these become strangulated with gangrene, a complication which has a mortality of up to 5% in the elderly (^{266, 267, 268, 269, 270, 271}).

In 1993, Watson demonstrated the feasibility of laparoscopic hernia repair (LHR) for incarcerated hernias (²⁷²).

In 2003, a Cochrane library study showed that the outcome of LHR, in elective surgery, is at least equivalent to that of the open approach (²⁷³). This study was confirmed, in 2010 by an extensive meta-analysis (²⁷⁴). On the other hand, there are no comparative studies between the laparoscopic and the open approach in emergency adult cases.

A review of cohort studies on laparoscopic repair of incarcerated groin hernias was published in 2009 by Deeba updating the information given in the previous guidelines on laparoscopic emergency (^{275, 2}). It reviews seven articles on this topic, dating from 1989 to 2008, reporting on 328 cases treated with TEP or TAPP. Of these seven articles, two are LE 2b prospective cohort studies and five are LE 4 small case series (^{276, 277, 278, 279, 280, 281, 282}). The overall results of Deeba's study were: average operative time 61.3 min, average hospital stay 3.8 days, mortality 0.28%, complications rate 10.3%, conversions 1.8%, and intestinal laparoscopic or mini-laparotomy

resections 5.1%, reoperations 0.9%. The most serious complications consisted of two colonic lesions and one divided vas deferens. The others were infected mesh (0.6%), wound infections (0.3%), deep venous thrombosis (0.3%) and other minor complications. The highest recurrence rate at 7 years was 5.8%. The authors concluded that the laparoscopic approach, either TEP or TAPP, is possible to repair incarcerated hernia taking into account the knowledge of anatomy and expertise needed to dissect and reduce the sac. Laparoscopy can also be used to resect bowel, if needed or to repair an occult contra lateral hernia, present in 11.2% to 50% of cases. The overall rate of complications, recurrences, and hospital stay seem to be very similar to the rates documented in open repair for strangulated/incarcerated hernias.

The "hernioscopy" is a new mixed laparoscopic-open technique for incarcerated hernias, which spontaneously reduce during the surgical manipulations. A randomized controlled study (LE 2b) suggested that this was effective technique, which involves the introduction of the laparoscope into the hernia sac, to evaluate the viability of the herniated loop, thus avoiding unnecessary laparotomy ⁽²⁸³⁾.

Only a few single or small case series studies (LE 4) are reported concerning the laparoscopic treatment of non-reducible retro-xiphoid diaphragmatic hernias). They all conclude the need for consensus on this subject ^(284, 285).

The acquired diaphragmatic para-esophageal incarcerated hernias are approached by laparoscopy by some authors in low-level studies (LE 4). The most important absolute contraindication to this procedure seems to be the presence of a gastric necrosis ^(286, 287, 288, 289).

The mini-invasive repair of rare abdominal wall acute hernias, such as supra-vescical and Spigelian, is rarely described. Most case reports (LE 4) concern emergency obturator hernioplasties, with good results in terms of resolution of symptoms and hospital stay ^(290, 291, 292, 293, 294, 295, 296, 297, 298, 299, 300, 301, 302).



Finally, there are several articles concerning the laparoscopic repair of incarcerated internal hernias, such as the para-duodenal, para-cecal, broad uterus ligament, trans-mesosigma and post-surgery hernias. Even though all of them are low LE, the potential role of laparoscopy in the diagnosis seems to be demonstrated and would, at times, prevent unnecessary laparotomies (303, 304, 305, 306, 307, 308, 309, 310, 311, 312, 313, 314, 315, 316, 317, 318, 319, 320, 321, 322).

Ventral hernias

The laparoscopic approach to incarcerated ventral and incisional hernia may be performed in selected patients (GoR B).

In 2005, the previous International Consensus Conference of the European Association of Endoscopic Surgery (EAES) stated that the open approach remains the standard treatment for incarcerated hernia, although laparoscopic surgery may be considered in carefully selected patients and restricted to surgeons with maximum expertise in this field (GoR C) (2).

In 2010, an Italian Consensus Conference of the main National Scientific Societies (SIC- Società Italiana di Chirurgia; ACOI - Associazione Chirurghi Ospedalieri Italiani; SICE - Società Italiana di Chirurgia Endoscopica and Italian Chapter of Hernia Society) on laparoscopic treatment of ventral and incisional hernia, underlined that the incidence of intra- and postoperative complications and recurrences in emergency cases, was the same as in elective cases. A good experience in emergency surgery and in laparoscopic repair of abdominal wall in elective patients is always strictly required. The grade of recommendation was increased to B (323).

Patients should be selected according to the following criteria:

- *Absence of marked abdominal distension* that precludes entry into the peritoneal cavity and limits adequate working space.



Some studies suggested that a small bowel diameter exceeding 4 cm, at a preoperative abdominal x-ray, and a late operation (>24 hours post-onset, > 6 hours post hospital admission) were risk factors for conversion (^{324, 325, 262, 257});(LE 4)

- Some authors have introduced introduce the *number (>4) of previous laparotomies* as a predictive factor of conversion (³²⁴). However, not only the number but also the type of previous procedure and the location of the surgical scars are very important. As far as adhesiolysis is concerned, one surgical xipho-pubic scar following an abdominal trauma or massive peritonitis will often give rise to more difficulties than three scars (for example in the right subcostal area, in the hypogastrium and in the right iliac region) resulting from elective and uncomplicated surgery (³²⁶); (LE5)
- *Absence of peritonitis* with the need for bowel resection and bowel handling in a highly inflamed environment (³²⁷) and *absence of clinical signs of intestinal ischemia*. (LE4)
- *Absence of high septic risk situations, such as concomitant execution of contaminated abdominal procedures or the presence of contaminated skin lesions or entero-cutaneous fistulae* (³²⁸);(LE4)
- *Absence of major defects* with loss of domain or hernias that do not allow the laparoscopic approach with adequate over-lap of the mesh (³²⁸);(LE4)
- *Absence of hemodynamic instability and severe co-morbid conditions such as heart and lung diseases that preclude the use of pneumoperitoneum* (³²⁷);(LE4)
- *Morbid obesity* (³²⁹), *old age and debilitation* are not considered contraindications to laparoscopy (^{326, 330}). (LE4)

As for operative technique the use of atraumatic graspers is essential, adhesiolysis should be proper and cautious and the contents in the defect should be always accurately checked for blood supply, motility and integrity.



If an enterotomy occurs, it can be repaired laparoscopically (LE 5).

The mesh is positioned intraperitoneal with an adequate overlap (at least 3 cm); the immediate mesh repair is preferably (³³¹, ³³², ³³³, ³³⁴) deferred only in cases of abundant peritoneal contamination or bowel necrosis (³²⁵). (LE 3b)

The introduction of biological meshes in clinical practice provides a new prospective for abdominal wall defect repair in the contaminated surgical field (³³⁵). A few authors have suggested the use of biomaterial in the laparoscopic emergency hernia repair with good results in terms of recurrence and wound infection (³³⁶, ³³⁷) (LE 4). There are no comparative trials evaluating the commercially available biological meshes products and their application in laparoscopic repair of potentially contaminated ventral hernias

Abdominal trauma

In stable penetrating trauma of the abdomen, laparoscopy may be useful in patients with documented or equivocal penetration of the anterior fascia. (GorB)

Laparoscopy should be considered in hemodynamically stable blunt trauma patients with suspected intra-abdominal injury and equivocal findings on imaging studies or even in patients with negative studies but with a high clinical likelihood for intra-abdominal injury (“unclear abdomen”) to exclude relevant injury (GoRC)

To optimize results, the procedure should be incorporated in institutional diagnostic and treatment algorithms for trauma patients (GorD).

Ultrasound and contrast-enhanced Computed tomography (CT) can be applied quickly and efficiently in trauma patients, but hemodynamic stability is a prerequisite for a CT. (³³⁸, ³³⁹).

Angiography is indicated to delineate and treat active bleeding of abdomen and pelvis, when detected by CT and/or other means (US, X-ray of pelvis and cystography) (³³⁹).

Diagnostic accuracy of laparoscopy has been reported as high as 75% (LE 2b) (³⁴⁰) is indicated in hemodynamically stable patients with suspected intra-abdominal lesions and equivocal findings on imaging studies, and when non-operative management is not indicated (suspected hollow viscus injuries with peritonitis, potential diaphragmatic lesion). The procedure has been shown to effectively decrease the rate of negative laparotomies and minimize patient’s morbidity. (³⁴¹, ³⁴²).

The procedure is usually performed under general anesthesia; however, local anesthesia with I.V. sedation has also been used successfully in the emergency department (“awake laparoscopy”) (LE 4)(³⁴³)



The positioning and draping of the patient should be as for trauma laparotomy so that if needed, conversion to open technique can be accomplished without loss of time. For this reason, the patient should be supine and the entire abdomen prepared and draped from the jugular sternal notch to the groin. ⁽³³⁸⁾

Pneumoperitoneum should be induced slowly and carefully. If the blood pressure drops and respiratory pressure suddenly rises, insufflation is stopped, or the gas pressure reduced ⁽³³⁸⁾.

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 ⁽¹⁸⁰⁾.

The surgeon should not hesitate to convert to an exploratory laparotomy if he or she is not confident that there are no missed injuries (LE 4)⁽³⁴²⁾.

In a highly selected group of patients therapeutic laparoscopy should be performed only by surgeons skilled in advanced mini-invasive surgery (LE 3a) ^(342, 344).

Therapeutic laparoscopic options have increased in the last years to manage hemoperitoneum, diaphragmatic, mesentery and hollow viscus injuries and to avoid non-therapeutic laparotomy diaphragmatic lacerations (LE 4) ^(345, 346, 347), and to treat perforating stab wounds of the gastrointestinal tract which can be sewn or stapled safely when laparoscopic expertise is available (LE 4) ^(342, 348, 349).

Procedure-related complications occur in up to 11% of patients: Tension pneumothorax in patients with diaphragmatic injury from positive-pressure pneumoperitoneum ^(350, 351), gas embolism in patients with intraabdominal venous injuries, especially in liver lacerations, causing the trans-peritoneal absorption of

carbon dioxide which may cause metabolic and hemodynamic changes such as acidosis, cardiac suppression, atelectasis, subcutaneous emphysema, and increased intracranial pressure, resulting in more profound consequences for the trauma patient.

A retrospective cost analysis comparing the total hospital costs of exploratory laparotomy versus diagnostic laparoscopy in 37 patients with penetrating abdominal trauma, showed that laparoscopy is 1136 Euro cheaper than exploratory laparotomy ⁽³⁵²⁾ although in a prospective, randomized study of 43 patients with abdominal stab wounds no statistically significant difference was found between the two strategies in the total hospital costs (LE 4) ⁽³⁴⁰⁾.

Acute Mesenteric Ischemia

Laparoscopy does not offer significant advantages in acute mesenteric ischemia besides a potential role as bedside and second look procedure (GoR C)

Acute mesenteric ischemia (AMI) is an uncommon but serious disease, which is often associated with other systemic illnesses and has poor prognosis ⁽³⁵³⁾. It is caused in 50% of cases by arterial obstruction, in 20-30% by non-occlusive arterial ischemia and in 5-15% by venous occlusion. AMI presents a high mortality rate (59-93%) ⁽³⁵⁴⁾ and prognosis is frequently to the timeliness of diagnosis ⁽³⁵⁵⁾.

With a sensibility of 93, 3% and a specificity of 95, 9% ⁽³⁵⁶⁾ multidetector CT is the best diagnostic approach in a patient with clinical suspicion of AMI (LE 1a). Few reports have been found concerning the diagnostic role of laparoscopy and literature data confirm that the laparoscopic picture of AMI depends on its stage (ischemia, infarct, peritonitis) and etiology (arterial thrombosis and embolism, venous thrombosis, non-occlusive mesenteric ischemia) ⁽³⁵⁷⁾. Since laparoscopy does not offer adequate diagnostic accuracy



in spite of the use of fluorescein and ultraviolet light (^{358, 359}) it does not appear to offer advantages compared with classic imaging although it may have a role as bedside laparoscopy in the ICU (³⁶⁰) (LE 4). There are no reports highlighting advantages of the use of laparoscopy in the treatment of patients with AMI.

The "laparoscopic second-look" might be an alternative option to the "surgical second-look" in patients already operated for acute mesenteric ischemia. (^{361, 362})(LE 4).

Discussion

Practice guidelines have to be regularly updated to be effective. A thorough literature review was necessary to assess whether the recommendations issued in 2006 are still current. In many cases new studies allowed us to better clarify some issues, but occasionally previous strong recommendations have to be challenged after review of recent research.

The accuracy of imaging techniques has enormously improved during the last few years, reducing the need to use laparoscopy as a sole diagnostic tool, thus avoiding the minimal insult of laparoscopic exploration in patients without any indication for laparoscopic treatment. On the other hand, surgical techniques have also progressed and the use of laparoscopic surgery is now widespread, increasing therapeutic laparoscopic options and allowing an even more refined diagnosis in those cases that could benefit from a laparoscopic procedure.

In the 2006 EAES consensus ventral and inguinal hernias were "lumped together". In our update we have chosen to separate the two entities as the diagnostic and the therapeutic choice for each of the two conditions are substantially different. In fact laparoscopic treatment of ventral hernias is more common than inguinal repair, and in the emergency setting their diagnosis relies on different



examinations. A recent Italian consensus on ventral hernia repair, issued a GoRB recommendation about laparoscopic ventral hernia repair, and therefore we raised the grade of recommendation for emergency repair. Hernia repair has gained a grade B in emergency situations (incarcerated or strangulated), thanks to recent reviews of cohort studies, reporting fair results. Interesting considerations have arisen, in this field, regarding "hernioscopy", particularly useful in association to emergent open repair to assess the viability of the herniated bowel once it has fallen back into the abdominal cavity. Surgeons have gained confidence with diagnostic laparoscopy over the last few years, and even if accuracy of the imaging techniques have improved at the same time, laparoscopy appears to be particularly useful when a laparoscopic treatment is also possible as in NSAP, gynaecological pathology and in small bowel obstruction. On the other hand the available imaging techniques reduce the indications of laparoscopy in mesenteric ischemia only to its bedside application and second-look operations. Some progress has also been seen in the treatment of acute cholecystitis, for which complicated disease (gangrenous or empyematous) or age are no longer considered contraindication for laparoscopic emergency treatment (GoR B). Moreover, laparoscopic cholecystectomy is feasible and has its place also in high-risk patients, as an alternative to percutaneous cholecystotomy or to conservative treatment, and has comparable results. Early cholecystectomy seems to have substantial advantages in the acute setting. Early (same admission) laparoscopic cholecystectomy is still advised after biliary pancreatitis, and interesting applications of retroperitoneoscopy start to gain evidence in the step-up approach to necrotic infections. Laparoscopic lavage and drainage in the treatment of Hinchey II-III diverticulitis has gained wider application. The role of laparoscopy in trauma is still limited to stable patients essentially to ascertain whether there has been peritoneal violation or for diagnosis in



"unclear abdomen" as a consequence of an equivocal diagnostic workup.

Some of the RCTs and reviews published in the last 5 years have raised some concerns, when compared to standard open treatments in some cases. This was the case of laparoscopic perforated peptic ulcer repair, in which morbidity due to suture leakage seems higher with laparoscopic repair: the panel agreed that the good outcomes experienced in everyday practice of laparoscopic perforated peptic ulcer have not been reflected in the available literature studies. Some reappraisal has been made for laparoscopic appendectomy, which is strongly recommended in fertile women but has not gained level I evidence for men, the obese, and the elderly or pregnant women due to conflicting RCTs' results. An effort to establish the right treatment recommendations for a normal appendix found at laparoscopy has been made.

The technique of pneumoperitoneum induction and surgical learning curve, both topics of general interest for the laparoscopic surgeon, have been widely discussed.

Concerning establishing pneumoperitoneum in the emergency setting the panel has not converged in opinion on the best single technique. This is due to the different preferences and practices of individual surgeons and the lack of evidence in the literature to favour a specific access (closed or open). Each access modality has its specific related complications and there is no clear evidence to suggest which is the best method for the individual patient's problem (bowel distension; previous laparotomies and so on). The surgeon's experience in using his chosen method is very important.

The panel agreed that the use of laparoscopy in an emergency setting requires surgical experience and skills, however in the literature there is no complete and objective definition of "experienced" and "skilled" and several factors limit our ability to reach such definitions. A specific "learning curve" for every single



situation is impossible to define, in particular, in an emergency laparoscopic setting, where the operative condition may be worsened by reduction of the surgical field (intestinal distension, adhesions), unclear anatomy due to the inflammatory status, and a wide variety of possible therapeutic findings. On the other hand there was a general agreement that experience gained in one specific procedure reduces the learning curve for other procedures because the judgement, ability, and the skills developed can be used in a large number of situations.

Every surgeon has to decide the best approach according to his or her own experience, the particular clinical situation, his/her proficiency (and the experience of the team) with the various techniques and the specific organizational setting in which he/she is working. A low threshold for conversion carries only minor disadvantages for the patient, and such a good judgment can obviate the need for a questionable strict definition of "expert laparoscopic emergency surgeon". These guidelines have been developed to help surgeons with their decisions in the very difficult situation of emergency surgery.



Effectiveness of laparoscopic surgery	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	+++	+++
Non-specific abdominal pain	+++	+++
Abdominal trauma	+?/-?	+

Table : EAES 2006 Guidelines “evidence” of effectiveness of laparoscopy in acute abdomen and 2011 Consensus ones (+: effectiveness from strongest +++ to weakest +; -: no effectiveness; ?: doubtful effectiveness)



ANNEX

ANAESTHESIA IN LAPAROSCOPIC SURGERY FOR ABDOMINAL EMERGENCIES

ANESTHESIOLOGICAL CONSIDERATIONS

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INTRODUCTION

The overall incidence of perioperative complications depends on several multidisciplinary factors. Patient physical status according to American Society of Anaesthesiologists (ASA) classification, emergency or routine interventions, intraoperative determinants (bleeding, long operating time), and the clinical experience of care-givers (mainly anaesthesiologists and surgeons).

All these factors can significantly affect the postoperative course (LE 2b)³⁶³.

The literature data regarding laparoscopy related complications and death rate are few, and show conflicting results. Bottger describes an overall postoperative hospital mortality rate of 2.6%, with cardiac or pulmonary complications predominating. A significant rate of deaths (10%) is associated with emergency surgery while elective surgery is burdened by a lower rate (2%).

General complications (up to 12% of the treated patients, according to Bottger data) are cardiac impairment, protracted ventilation, cerebral complications, reanimation, pneumonia, and urinary tract infection. Surgical-site infection, anastomotic leak, bleeding, and sepsis mainly represent surgical complications. A significant correlation has been reported between cardiac complication, the need for protracted ventilation and ASA patient

physical status, surgery duration and requirement for blood transfusion. A close correlation between the anaesthesiologist's skill and perioperative complications has been also described (LE 2b)³⁶³.

Total operative time has been reported to be significantly affected in patients with incarcerated hernia contents preoperatively, suprapubic hernia location, bowel adhesion to the abdominal wall or hernia sac, a greater number of previous ventral hernia repairs, and larger hernia defects. Total operative time may be also affected by a higher ASA classification and hernias requiring a larger mesh for repair (LE 2b)³⁶⁴. During laparoscopy, pneumoperitoneum (PP) may result in intraoperative atelectasis. Positive end expiratory pressure (PEEP) of 5 cmH₂O in pressure-controlled ventilation (PCV) mode has been suggested by Ji et al to protect pulmonary gas exchange during surgery (LE 2b)³⁶⁵.

Conversely Luz-Moreira found that Laparoscopic Colectomy (LC) could be a safe option for patients with a high ASA classification as the LC approach is associated with faster postoperative recovery, lower morbidity rates, and lower hospital costs than the Open Colectomy (OC) approach (LE 2b)³⁶⁶. This Author reported an overall morbidity rate of 24% with an overall postoperative morbidity and wound infection rate significantly lower in the LC group than in the OC group and no difference in terms of 30-day re interventions or postoperative mortality between the two groups. Interestingly the LC group had also a significantly less estimated blood loss. Luz-Moreira concluded that LC should be considered safe for ASA 3 and 4 patients and is associated with faster postoperative recovery, lower morbidity, and similar hospital costs compared with OC.

The literature did not systematically report pulmonary complications, and most studies did not have sufficient statistical power to detect differences in postoperative pulmonary complication rates (LE 2a)³⁶⁷ so that it is not clear whether laparoscopic procedures reduce the risk for clinically important pulmonary complications.

A detailed multidisciplinary strategy has been described by Patel et al to facilitate early recovery (LE 4)³⁶⁸. In patients undergoing a laparoscopic procedure antibiotics administration is planned prior to surgery, followed by 8–10 mg dexamethasone at induction of anaesthesia. The surgical approach is performed with no use of drains and tubes, urinary catheter (for right and transverse colon resections) and immediate removal of catheter after low anterior colon resections. Epidural anaesthesia is also avoided. However a careful choice of the anaesthetic technique should be tailored to the type of surgery. General anaesthesia (balanced anaesthesia technique with several intravenous and inhalational agents and the use of muscle relaxants); peripheral nerve blocks and neuraxial anaesthesia alternative to general anaesthesia for outpatient pelvic laparoscopy; local anaesthesia infiltration in micro laparoscopy for limited and precise gynaecologic procedures; intravenous sedation can be performed and have been described in literature with safe profile for patients (LE 5)³⁶⁹, (LE 4)³⁷⁰, (LE 2b)^{371,372}, (LE 1b)³⁷³, (LE 1a)³⁷⁴, (LE 4)³⁷⁵, (LE 1b)^{376,377}, (LE 2b)^{378,379}, (LE 1b)³⁸⁰. Laparoscopy is most commonly performed with the patient under general anaesthesia especially for prolonged and upper abdominal procedures. However regional techniques involving peripheral and neuraxial blocks and local anaesthetic infiltrations could be used for pelvic laparoscopy. Finally spinal and epidural anaesthesia and combination of the two have been described as suitable for pelvic laparoscopy.

Standardization of the surgical technique, resulting in a reduced surgical time, a “bloodless” surgery, standardization of intraoperative monitoring, and employment of skilled anaesthesiologists for high-risk patients may partially modify the rate of perioperative complications but other factors such as obesity, ASA classification, and urgency of the intervention cannot be influenced by clinicians.



Suggestions

The patient should be evaluated by the whole team (surgeon, anaesthetist, and radiologist) with the aim to define risk/benefit ratio.

PATIENT ELIGIBILITY FOR LAPAROSCOPIC PROCEDURES

Preoperatively, the patients should be submitted to a comprehensive physical examination, followed by further investigations (laboratory and instrumental diagnostic evaluations such as electrocardiogram, plain chest X-ray, internistic workup consultation), and the ASA score in order to properly plan the anaesthesia management. Prior to surgery, according to E.A.E.S. guidelines, (LE 1b)³⁸¹ patient scheduled for laparoscopic surgery should be evaluated regarding the presence of comorbidities, assessment of ASA III-IV, COPD, NYHA III-IV, CRF. The presence of heart disease should not constitute an absolute contraindication to laparoscopic surgery (LE 2b)³⁸² since perioperative risks can be reduced adopting the most appropriate anaesthesia and/or surgical treatment option. In trauma patients a minimally invasive approach could be useful and safe as it can reduce the potential morbidity of negative laparotomy (LE 3a)³⁸³.

Suggestions

Hemodynamic and respiratory stability parameters stability is necessary to perform laparoscopic procedures. Major trauma patients or patients with severe disease may be eligible if lasting hemodynamic and respiratory parameters stability is achieved after resuscitation and/or intensive medical treatment.

PATHOPHYSIOLOGICAL CHANGES DURING LAPAROSCOPY

In laparoscopic surgery PP is the crucial element affecting respiratory mechanisms and cardiovascular responses, especially in patients with comorbidities. The knowledge of pathophysiologic



changes is essential in order to plan an appropriate anaesthesia strategy aimed to early detect and prevent potential complications.

Respiratory effects

PP, shifting the diaphragm upwards, decreases the lung compliance, leading to a diminished functional residual capacity, closing volume related. Even if uncommon in healthy patients (LE 1b)³⁸⁴ a ventilation-perfusion mismatch may also occur, sometimes resulting in perioperative hypoxemia (LE 1b)^{385,386,387}; (LE 2a)³⁸⁸. Lung volume decrease, associated to airway (P_{aw}) and intra-abdominal pressure (IAP) increase may lead to lung atelectasis, mainly in patients with extensive pulmonary disease (LE 1b)^{381, 369}.

IAP higher than 15 mm/Hg associated with the Trendelenburg position should be avoided because they may severely reduce pulmonary compliance causing a ventilation-perfusion mismatch (LE 1b)³⁸⁹.

Transperitoneally CO_2 absorption determines higher end-tidal CO_2 ($EtCO_2$) 8-10 minutes after gas insufflations, irrespective of the site and duration of administration; increased minute ventilation maintains $PaCO_2$ in normal limits in most cases, possibly leading to further increase in airway pressure (LE 1b)^{390,391}. Increased arterial CO_2 content might not be accurately reflected by $EtCO_2$ perhaps as a consequence of increased dead-space PP induced.

Cardiovascular effects

Major hemodynamic alterations include hypotension, hypertension, arrhythmias and cardiac arrest; the cardiovascular effects of PP occur during gas insufflations and are associated to IAP levels, volume of CO_2 absorbed, patient's intravascular volume, co-morbidities and positioning, with IAP and patient positioning representing the most important determinants of cardiovascular function during laparoscopy (LE 1b).

Abdominal venous compression causes a decline in venous return and preload, due to a reduced flow through the inferior vena

cava (LE 1b)^{389,392}; IAP and the stimulated neurohormonal vasoactive system cause an increase in mean arterial pressure, systemic vascular resistance (SVR) and pulmonary vascular resistance (PVR), resulting in an increased afterload (LE 1b)³⁹³.

Preload and afterload combined variations may cause a decrease in cardiac output (CO) with a further detrimental effect following head-up positioning and patient's inadequate intravascular volume content (LE 1b)³⁹⁴.

Although venous return decreases during PP, central venous pressure (CVP) and pulmonary capillary wedge pressure (PCWP) rise during abdominal insufflations probably due to a cephalic shift of diaphragm with an increased intra-abdominal and intrathoracic pressure. In ASA I and II patients, hemodynamic changes at a IAP level lower than 15 mm/Hg are not clinically relevant and vanish after desufflation (LE 1b)³⁸¹.

Regional perfusion (brain, kidney, liver, and bowel) may also be affected by the rise of IAP (LE 1b)³⁹⁵; these changes should be considered especially in patients with impaired hepatic and/or renal function or modified cerebral hemodynamic (LE 5)³⁹⁶. Accordingly to previous data, IAP level should be as low as possible in critical ill patients undergoing laparoscopic surgery for abdominal urgencies.

Monitoring during anaesthesia

During anaesthesia, standard and comprehensive monitoring (HR, ECG, BP, SpO₂, EtCO₂, P_{aw}, and body temperature) should be applied to enrolled patients. Airway pressures, both peek and plateau pressures, should be monitored during the whole procedure; it is necessary to closely monitor P_{aw} at the time of induction of PP with the aim to adjust given P_{aw} to new acceptable values. Monitoring the changes of airway pressures during PP enables the early detection of atelectasis (LE 5)³⁹⁷.

Even if EtCO₂ doesn't accurately reflect PaCO₂ changes, it should be used to indirectly assess arterial CO₂ rise and to titrate minute ventilation with the aim to correct increased plasma CO₂

concentrations (LE 1b)³⁸¹. In patients with compromised cardiopulmonary function a frequently control of arterial blood gas analysis may be necessary, as PaCO₂ /EtCO₂ gradient (LE 1b) may change; therefore an arterial line positioning is suggested in ASA III and IV patients.

CVP rise following PP institution may lead to possible misinterpretation of preload status; as for airway pressure, measurement before and after PP application makes possible to detect hemodynamic changes and properly assess the true patient volemia. In ASA III and IV patients invasive monitoring of arterial blood pressure and of circulating volume is strongly suggested (LE 1b)³⁸⁴.

Suggestions

Standard monitoring (monitoring (HR, ECG, BP, SpO₂, EtCO₂, P_{aw}, body temperature) for general anaesthesia should be performed. Invasive arterial blood pressure and circulating volume monitoring is strongly suggested in ASA III and IV patients.

Ventilatory strategies to protect the lung

A rational approach to overcome the rise of PaCO₂ and acidosis is controlled mechanical hyperventilation (LE 1b)³⁹⁰; as a detrimental ventilator-induced lung injury (VILI) is closely related to high-volume/high pressure mechanical ventilation mode, especially during long lasting procedures, therefore PaCO₂ decrease should be achieved through higher respiratory rate thus avoiding tidal volume increase.

PEEP is a rational strategy to maintain the lung open and prevent lung injury and atelectasis (LE 5)³⁹⁷. In fact PEEP application increases alveolar recruitment especially in patients at greater risk of atelectasis (obese, underlying lung disease patients (LE 1b)³⁹⁸. In case of atelectasis, hypoxemia can develop both during anaesthesia and in the postoperative period. The first line treatment is to

increase inspiratory fraction of oxygen (FiO_2), keeping in mind that oxygen toxicity might injure the lung.

Actually there is no evidence to suggest that pressure-controlled ventilation is better than volume-controlled ventilation to prevent lung injury and improve oxygenation during laparoscopic surgery, even if “peak pressure “ is limited with pressure-controlled ventilation (LE 1b)^{399,400}.

Suggestions

In order to improve the patient oxygenation, respiratory rate increase is safer than higher tidal volume. Positive end-expiratory pressure (PEEP) is suitable to “open up the lung and keep it open”. Recruitment manoeuvres are useful in recruiting the collapsed alveoli.

Non ventilatory strategies to protect the lung: positioning and anaesthesia

Reverse Trendelenburg position improves respiratory mechanisms and oxygenation, while the Trendelenburg position worsens lung compliance during PP (LE 3b)⁴⁰¹. In a recent review Valenza et al (LE 5)³⁹⁷ reported that head-up positioning alone or PEEP in supine position have the same effects on lung volume and oxygenation, while P_{aw} is lower in the beach-chair position. However the Authors prefer head-up positioning, if appropriate, to protect the lung. In case of Trendelenburg position, a close monitoring of P_{aw} is mandatory to titrate the mechanical ventilation parameters so as to prevent lung strain and atelectasis formation.

At the moment, there are no available data to make either inhalational or intravenous anaesthesia preferable for laparoscopy. However in 1998 Gehring and co-authors found PaCO_2 levels significantly higher and PaO_2 concentrations significantly lower in patients undergoing isoflurane anaesthesia rather than in patients undergoing propofol anaesthesia (LE 1b)⁴⁰².



Suggestions

The reverse Trendelenburg position is associated with an improvement of lung compliance and a decrease of P_{aw} . In the Trendelenburg position it is mandatory to strictly monitor the P_{aw} in order to titrate the mechanical ventilation parameters so as to prevent lung strain and atelectasis formation.

Anaesthesia and laparoscopic surgery in obese patients

The obese patient is generally evaluated as a complicated patient. Merkow found an adverse correlation between body mass index (BMI) and short-term outcomes in cancer patients undergoing open colectomy. The morbidly obese group was found to have a higher morbidity rate than normal weight patients, particularly in relation to such complications as wound infection, dehiscence, pulmonary embolism, and renal failure (LE 1a)⁴⁰³. At the same time Scheidbach et al. evaluated laparoscopic colorectal resection in overweight, obese, and morbidly obese patients and reported equivalent outcomes for these groups; however no extensive investigation of the correlation between the degree of BMI, the feasibility of laparoscopic colon resection, the benefits, and the short-term outcomes was provided (LE 1a)⁴⁰⁴. Respiratory function is markedly impaired in morbidly obese patients ($BMI \geq 40 \text{ kg/m}^3$) undergoing laparoscopic surgery. Several factors contribute to affect pulmonary function: supine position, muscle paralysis, and PP (LE 2b)^(405,406). The related reduced functional residual capacity, increased closing volume, and consequent atelectasis (EL 3a)^{407,408} increase the risk for postoperative respiratory complications (LE 1b)⁴⁰⁹ and prolonged hospital length of stay (LE 1b)⁴¹⁰. Almarakbi found that recruitment with the inspiratory manoeuvre repeated every 10 min followed by PEEP application of 10 cm H₂O was associated with the best intraoperative respiratory compliance, that is a PaCO₂ decrease and PaO₂ increase in obese patients

undergoing laparoscopic gastric banding without adverse events (LE 1b)⁴⁰⁰.

Intraoperative ventilatory strategies should be adopted to improve gas exchange and prevent Ventilation Induced Lung Injury (VILI). If these strategies are followed, laparoscopic procedures may be performed even in morbidly obese patients, with clinical outcomes (recovery of intestinal function and LOS) equivalent to those for non-obese patients. However, the complication rate (morbidity and conversion rates) is higher for morbidly obese patients undergoing LC than for non-obese patients.

Suggestions

The morbidly obese group has a higher morbidity rate than normal weight patients. As the most frequent complications are respiratory, intraoperative ventilatory strategies should be adopted to improve gas exchange and prevent Ventilation Induced Lung Injury (VILI).

Anaesthesia and laparoscopic surgery in pregnant patients

According to some evidences in the literature, laparoscopic surgery in pregnancy seems to be a safe option. The most common indications are cholelithiasis, appendicitis, persistent ovarian cyst, adnexal torsion (LE 5)^{411,412}, splenectomy (LE 4)⁴¹³, heterotopic pregnancies and adrenal pheochromocytoma (LE 4)⁴¹⁴. Interestingly Sagiv reported a significant number of successful cases of laparoscopic surgery for extrauterine pregnancy in hemodynamically unstable patients (LE 2b)⁴¹⁵. However changes in respiratory and cardiovascular function may be present: adding PP to an abdomen during pregnancy is generally associated with significant increase in peak airway pressure, decrease in functional reserve capacity, increased pulmonary shunt, increased alveolar-arterial oxygen gradient, decreased respiratory compliance (LE 4)⁴¹⁶. As a consequence anaesthesiologists should pay special attention to

patient positioning during surgery and the physiologic and mechanical effects following CO₂ PP realization.

CO₂ and fetal heart monitoring and prophylaxis for deep vein thrombosis should be performed during laparoscopic procedures. End-tidal carbon dioxide and maternal blood pressure should be respectively maintained between 32- 34 mm/Hg and within 20% of baseline values. Finally abdominal insufflation pressure of carbon dioxide should not rise above 12-15 mm/Hg. (LE 5)⁴¹⁷. The Society of American Gastrointestinal Endoscopic Surgeons (SAGES) published guidelines for laparoscopic surgery during pregnancy that include perioperative monitoring of arterial blood gases as well as perioperative fetal and uterine monitoring reinforced in a practice guideline in 2000. However the anaesthesia management for pregnant women undergoing laparoscopic surgery does not differ from anaesthesia during pregnancy for any other procedure (LE 5)⁴¹⁸.

Suggestions

Changes in respiratory and cardiovascular function may be observed in pregnant women: adding PP to an abdomen may lead to a significant increase in peak airway pressure, decrease in functional reserve and capacity, increased pulmonary shunt, increased alveolar-arterial oxygen gradient and decreased respiratory compliance. As a consequence, special attention should be paid to patient positioning during surgery and to the physiologic and mechanical effects following CO₂ pneumoperitoneum realization.

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