EAES consensus statement

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SURGICAL ENDOSCOPY and Other Interventional Techniques

Laparoscopy for abdominal emergencies

Evidence-based guidelines of the European Association for Endoscopic Surgery

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Abstract
Background: Emergency laparoscopic exploration can be used to identify the causative pathology of acute abdominal pain. Laparoscopic surgery also allows treatment of many intraabdominal disorders. This report was prepared to describe the effectiveness of laparoscopic surgery compared to laparotomy or nonoperative treatment.
Methods: A panel of European experts in abdominal and gynecological surgery was assembled and participated in a consensus conference using Delphi methods. The aim was to develop evidence-based recommendations for the most common diseases that may cause acute abdominal pain.
Recommendations: Laparoscopic surgery was found to be clearly superior for patients with a presumable diagnosis of perforated peptic ulcer, acute cholecystitis, appendicitis, or pelvic inflammatory disease. In the emergency setting, laparoscopy is of unclear or limited value if adhesive bowel obstruction, acute diverticulitis, nonbiliary pancreatitis, hernia incarceration, or mesenteric ischemia are suspected. In stable patients with acute abdominal pain, noninvasive diagnostics should be fully exhausted before considering explorative surgery. However, diagnostic laparoscopy may be useful if no diagnosis can be found by conventional diagnostics. More clinical data are needed on the use of laparoscopy after blunt or penetrating trauma of the abdomen.
Conclusions: Due to diagnostic and therapeutic advantages, laparoscopic surgery is useful for the majority of conditions underlying acute abdominal pain, but noninvasive diagnostic aids should be exhausted first. Depending on symptom severity, laparoscopy should be advocated if routine diagnostic procedures have failed to yield results.

Key words: Abdominal pain — Emergencies — Laparoscopy

Acute complaints referable to the abdomen are common presentations in surgical emergency departments. Abdominal pain is the leading symptom in this context. In the context of these guidelines, we define acute abdominal pain as any medium or severe abdominal pain with a duration of less than 7 days. Some of the conditions that cause abdominal pain prove to be self-limiting and benign, whereas others are potentially life-threatening. Since it is often difficult to identify patients who have critical problems early in the course of their disease, laparoscopy offers a superior overview of the abdominal cavity with minimal trauma to the patient.

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Table 1. Observational studies on the routine use of laparoscopy in unselected patient cohorts

Study year[a]	No. of patients	Percentages of appendicitis/cholecystitis/ gynecological disorders	Definitive diagnosis possible (%)	Percentage of laparoscopic/open surgical/conservative therapy	Avoidance of open surgery (%)
Reiertsen et al., 1985 [225]	81	23/0/23	86	0/35/38	38
Paterson-Brown et al., 1986 [211]	125	NA	91	0/30/70	9
Nagy and James, 1989 [193]	31	29/3/23	90	6/45/48	55
Graham et al., 1991 [99]	79	32/NA/35	99	NA/34/NA	66
Schrenk et al., 1994 [236]	15	67/7/7	93	80/20/0	80
Geis and Kim, 1995 [94]	155	66/5/1	99	96/4/0	96
Navez et al., 1995 [198]	225	18/48/5	93	73/27/0	73
Waclawiczek et al., 1997 [282]	172	17/28/NA	NA	65/28/7	72
Chung et al., 1998 [57]	55	22/15/11	100	62/38/0	62
Salky and Edye 1998 [231]	121	50/0/13	98	43/19/38	91
Sözüer et al., 2000 [252]	56	38/4/32	95	64/13/23	87
Ou and Rowbotham 2000 [207]	77	7/1/52	NA	87/12/1	88
Ahmad et al., 2001 [4]	100	37/23/29	NA	81/19/0	81
Lee and Wong, 2002 [157]	137	25/9/39	91	41/16/43	84
Kirshtein et al., 2003 [130]	277	23/1/9	99	75/25/0	75
Sanna et al., 2003 [232]	94	20/6/26	98	88/12/0	88
Agresta et al., 2004 [2]	602	NA/27/61	96	94/16/0	94
Golash andWillson, 2005 [98]	1320	69/1/10	90	83/7/10	93
Majewski, 2005 [176]	108	41/11/15	100	87/13/0	87

NA, not assessed
[a] Studies are ordered according to year of publication

On the other hand, the risks of applying laparoscopy to emergency patients include delay to definitive open surgical treatment, missed diagnoses, and procedure-related complications.

Principally, two different clinical scenarios have to be considered. Either a specific condition can be assumed after diagnostic workup or the reason for the abdominal pain has remained uncertain. Therefore, laparoscopy has a diagnostic but also a therapeutic role. The history of diagnostic laparoscopy covers several decades. In an early study from 1975, Sugarbaker et al. [256] showed that in more than 90% of patients a diagnosis can be established by laparoscopy, thereby avoiding non-therapeutic laparotomy in the majority of cases. Table 1 summarizes several cohort studies of diagnostic laparoscopy, which show that over the years increasingly more patients could be successfully managed exclusively by means of laparoscopic surgery. In parallel, specific laparoscopic procedures were evaluated with regard to their effectiveness in the elective and emergency setting. Today, it is possible to hypothesize that all patients with acute abdominal pain would benefit from laparoscopic surgery. It is the aim of these guidelines to define which subgroups of patients should undergo laparoscopic instead of open surgery for abdominal pain.

Methods

Consensus development

In their meeting on September 11th, 2004, the Scientific and Educational Committee of the European Association for Endoscopic Surgery (EAES) decided to focus new clinical guidelines for the role of laparoscopy in abdominal emergencies. These guidelines were primarily intended to supplement the existing guidelines on specific diseases (e.g., appendicitis and diverticulitis) and secondly to define the role of laparoscopy for other, more rare conditions. Based on a review of the current literature, European experts were invited to participate in the development of the guidelines. All members of the expert panel were asked to define the role of laparoscopy in the various diseases that may underlie abdominal emergencies. For each disease, two experts summarized independently the current state of the art. From these papers and the results of the literature review, a preliminary document with recommendations was compiled.

In April 2005, the expert panel met for 1 day to discuss the text of the guideline recommendations. All key statements were reformulated until a 100% consensus within the group was achieved [190]. Next, these statements were presented to the audience of the annual congress of EAES in June 2005. Comments from the audience were collected and partly included in the manuscript. The final version of the guidelines was approved by all experts in the panel. Each "chapter" consists of a key statement with a grade of recommendation (GoR) followed by a commentary to explain the rationale and evidence behind the statement.

Literature searches and appraisal

We used the Oxford hierarchy for grading clinical studies according to levels of evidence. Literature searches were aimed at finding randomized (i.e., level 1b evidence) or nonrandomized controlled clinical trials (i.e., level 2b evidence). Alternatively, low-level evidence (mainly case series and case reports; i.e., level 4 evidence) was reviewed. Studies containing severe methodological flaws were downgraded. For each intervention, we considered the validity and homogeneity of study results, effect sizes, safety, and economic consequences.

Systematic literature searches were conducted on Medline and the Cochrane Library until June 2005. There were no restrictions regarding the language of publication. Database searches combined the key word laparoscopy (or laparosc* as title word) with a condition-specific keyword (e.g., diverticulitis). We also paid attention to studies that were referenced in systematic reviews or previous guidelines [35, 134, 214, 275].

Results

General remark

The wide variability in experience with laparoscopy makes it necessary to state that the following recom-

Table 2. Randomized and nonrandomized controlled trials comparing laparoscopic and open repair for perforated gastroduodenal ulcers[a]

Study, year	LoE	No. of patients	Leakage rates (%)	Total complication rates (%)	Difference in hospital stay (d)
Lau et al., 1996 [153]	1b	48/45	2/2	23/22	±0 n.s.[b]
Siu et al., 2002 [246]	1b	63/58	2/2	25/50	−1 sign.[c]
Johansson et al., 1996 [119]	2b	10/17	10/7	30/20	−1 n.s.[b]
Sø et al., 1996 [250]	2b	15/38	0/0	7/24	−2 n.s.[b]
Miserez et al., 1996 [74, 185]	2b	18/16	NA	50/9	−1 n.s.[b]
Chung et al., 1998 [57]	2b	3/3	NA	NA	−4 sign.[c]
Kok et al., 1999 [135]	2b	13/20	NA	8/15	−1 n.s.[b]
Næsgaard et al., 1999 [191]	2b	25/49	4/0	28/14	±0 n.s.[b]
Bergamaschi et al, 1999 [21]	2b	17/62	0/0	29/34	−2 n.s.[b]
Mehendale et al, 2002 [180]	2b	34/33	0/0	3/6	−5 sign.[c]
Lee et al., 2001 [155]	3b[d]	155/219	13/2	NA	−1 n.s.[b]
Nicolau et al., 2002 [202]	3b[d]	51/105	0/0	6/7	−2 sign.[c]
Seelig et al., 2003 [240]	3b[d]	24/31	4/3	13/26	−2 n.s.[b]
Tsumura et al., 2004 [272]	3b[d]	58/13	NA	5/23	−12 sign.[c]
Lam et al., 2005 [148]	3b[d]	523/1737	NA	3/13	−3 sign.[c]

LoE, level of evidence; NA, not assessed; n.s., not significant
[a] Data are shown for laparoscopic / open group. Studies are ordered according to LoE and year of publication
[b] Data are difference of medians
[c] Data are difference of means
[d] Study was downgraded because type of surgery was selected according to the patient's status or because converted cases were not analyzed within the laparoscopic group

mendations are valid only for surgeons or surgical teams with sufficient expertise in laparoscopic surgery.

Gastroduodenal ulcer

If symptoms and diagnostic findings are suggestive of perforated peptic ulcer, diagnostic laparoscopy and laparoscopic repair are recommended (GoR A).

Perforation is the most dangerous complication of gastroduodenal ulcer disease and accounts for approximately 5% of all abdominal emergencies [208, 298]. In perforated peptic ulcer, surgery is generally superior to conservative treatment evidence level (EL) 1b [27, 61]), also because surgical procedures have improved considerably (EL 1a [184]). Laparoscopic repair of perforated ulcer was first reported in 1990 by Mouret et al. [188]. In two randomized trials, laparoscopic surgery was found to be superior to open surgery for perforated ulcers (EL 1b [153, 246]), and other nonrandomized comparison studies are in accordance with these two trials (Table 2). Complication rates in these studies are strongly influenced by the selection of patients for surgery. Contradictory results were found on postoperative pain levels because there appears to be no difference in pain immediately after surgery (when pain is mainly caused by peritoneal inflammation), but laparoscopic patients seemingly experienced less pain later on (when pain is mainly caused by the incision) (EL 2b [21, 135, 185, 191]). Decreased pain may also account for shorter hospital stay and earlier return to normal activities. Long-term results of both procedures showed no major differences in complication or recurrence rates. Mortality was marginally higher after open surgery, although revisional surgery was more frequently required after laparoscopic surgery (EL 2a [152]).

Many patients in these studies received omental patch repair rather than simple suture, but there is nearly no comparative evidence available to decide which repair technique is superior (EL 2b [44, 137, 155, 178, 194, 247]; EL 4 [44, 137, 178, 194, 247]). One trial by Lau et al. compared patch repair with fibrin sealing without finding any differences (El 1b [153]). Conversion to an upper midline incision may be necessary in approximately 10–20% of operations, usually for multiple, large, or rear side perforations and for advanced peritonitis (EL 4 [60, 62, 66, 110, 244]), Nevertheless, conversion does not seem to worsen the clinical outcome compared to open surgery (EL 2b [57]). The treatment of bleeding gastroduodenal ulcers was considered to fall outside the field of the current guidelines.

Acute cholecystitis

Patients with acute cholecystitis should undergo laparoscojoic cholecystectomy (GoR A). Surgery should be carried out as early as possible after admission (GoR A). In patients unsuitable for early surgery, conservative treatment or percutaneous cholecystostomy should be considered (GoR B).

Laparoscopy is of minor importance in terms of diagnosis of acute cholecystitis. Studies have shown that the following diagnostic criteria define cholecystistis with nearly 100% specificity: (a) acute right upper quadrant tenderness for more than 6 h and ultrasound evidence of acute cholecystitis (the presence of gallstones with a thickened and edematous gallbladder wall, positive Murphy's sign on ultrasound examination, and pericholecystic fluid collections) or (b) acute right upper quadrant tenderness for more than 6 h, an ultrasound image showing the presence of gallstones, and one or more of the following: temperature above 38°C, leukocytosis greater than 10×10/L, and/or C-reactive protein level greater than 10 mg/L (EL 1a [270]).

Traditional treatment consisted of open cholecystectomy, which was performed several weeks after an attack or in the acute setting. With the introduction of

Table 3. Randomized and nonrandomized controlled trials comparing laparoscopic and open cholecystectomy for acute cholecystitis[a]

Study, year	LoE	No. of patients	Preoperative duration of symptoms	Total complication rates (%)	Difference in hospital stay (d)
Kiviluoto et al., 1998 [131]	1b	32/31	4 d (mean)	3/42	−2 sign.[b]
Johansson et al., 2005 [122]	1b	35/35	72 h (mean)	2/3	−0 sign.[b]
Kum et al., 1994 [144]	2b	66/43	24–96 h	10/9	−1 sign.[b]
Rau et al., 1994 [224]	2b	102/114	NA	9/11	−2 sign.[c]
Carbajo Caballero et al., 1998 [41]	2b	30/30	NA	NA	−7 sign.[c]
Lujan et al., 1998 [170]	2b	114/110	< 72 h	14/23	−5 sign.[c]
Araujo-Teixeira et al., 1999 [12]	2b	100/100	Variable	10/32	−7 sign.[c]
Pessaux et al., 2001 [218]	2b	50/89	NA	18/21	−5 sign.[c]
Chau et al., 2002 [48]	2b	31/42	Surgery performed 2 d (mean) after admission	13/40	−3 sign.[c]
Eldar et al., 1997 [71]	3b[d]	97/146	72 h (median)	17/26	−4 sign.[b]
Glavic et al., 2001 [97]	3b[d]	94/115	72 h (mean)	10/17	−4 sign.[c]
Bove et al., 2004 [33]	3b[d]	87/153	NA	14/NA	NA
Lam et al., 2005 [148]	3b[d]	1223/1408	NA	1/5	−4 sign.[c]

LoE, level of evidence; NA, not assessed
[a] Data are shown for laparoscopic/open group, Studies are ordered according to LoE and year of publication
[b] Data are difference of medians
[c] Data are difference of means
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laparoscopy for the surgical approach to gallstone disease acute, cholecystitis was initially considered a contraindication. However, with increasing experience, a number of reports became available demonstrating the feasibility of the laparoscopic approach with an acceptable morbidity [143, 144, 286]. Today, there is sufficient evidence to state that laparoscopy is a safe approach, but the question to ask is if it is clearly superior to an open approach. There are several published studies comparing laparoscopic and open cholecystectomy for acute cholecystitis (Table 3). Only two of them are randomized trials (EL 1b [122, 131]). Nearly all comparative studies demonstrated faster recovery and shorter hospital stay in favor of laparoscopy (EL 1a [152]). Similarly, a minilaparotomic cholecystectomy was studied by Assalia et al. (EL 1b [14]), who were able to reduce hospital stay from 4.7 days with open surgery to 3.1 days with minilaparotomy. However, in the most recently published study, the outcome was very similar in the laparoscopic and conventional groups (EL 1b [122]).

The question remains whether the favorable outcome for laparoscopy is a result of altered pathophysiological response to the operation or whether this is due to concomitant changes in postoperative care due to the expected faster recovery from laparoscopic surgery. There is a clear possibility that trials comparing open and laparoscopic procedures contain traditional care regimens that have not been revised in the open treatment groups but have been modified in the laparoscopic groups, thereby favoring, the expected improved outcome after minimally invasive surgery. Several studies in which hospital stay and convalescence were utilized as endpoints may merely reflect traditions of postoperative care and patient expectations associated with open procedures rather than differences between open and laparoscopic surgical techniques. However, even after the advent of fast-track surgery, the existing evidence supports the use of laparoscopy in terms of earlier postoperative recovery. The basic recommendation should therefore be to offer all patients a laparoscopic approach. If there is no laparoscopically trained surgeon available, the patient should be treated with an open operation in the acute phase of the disease.

The optimal timing of the operation, regardless of whether performed laparoscopically or conventionally, is of major importance. In fact, timing of surgery seems more important than choice of surgical approach. A large number of studies have compared early versus late cholecystectomy for acute cholecystitis (EL 1a [23, 210]; EL 1b [45, 120, 121, 136, 146, 169], EL 2b [24, 25, 49, 69, 93, 102, 133, 139, 173, 199, 215, 220, 242, 258, 273, 285, 295]). However, the time intervals for early, delayed, or interval surgery were inconsistently defined in these studies. It can be concluded from these studies that conversion rates, complication rates, convalescence times, and hospital costs rise in parallel with an increasing delay between admission and operation (EL 5 [96]). Unfortunately, it is impossible to define the exact time limit until which surgery should be performed, but the majority of studies considered a delay of more than 48 or 72 h to be suboptimal. Delaying surgery is considered potentially harmful, especially in patients with a clinical presentation of gangrenous or hemorrhagic cholecystitis (EL 2b [105, 181]), but laparoscopic surgery in these advanced stages of cholecystitis is technically very demanding.

When performing laparoscopic cholecystectomy, the threshold for conversion should be quite low (EL 4 [168]). In many patient series, conversion rates were between 5 and 40% (EL 4 [15, 33, 36, 48, 70, 80, 95, 105, 140, 168, 199, 215, 230, 258, 268, 295])—much higher than in elective cholecystectomy for uncomplicated cholecystolithiasis. A set of prognostic variables have been identified that predict the need for conversion, such as degree of inflammation, number of previous gallbladder colics, gallstone size, higher age, male gender, obesity, and surgical, expertise (EL 4 [12, 102, 156, 168,

241]). However, these variables do not allow a completely reliable identification of patients in whom laparoscopic cholecystectomy is impossible. Therefore, every surgical procedure for acute cholecystitis should be started laparoscopically, except for patients with general contraindications.

Despite its general superiority, early laparoscopic cholecystectomy may not be possible in all patients. In elderly patients, comorbidities often render early surgery too risky or they simply preclude anesthesia (EL 5 [39]). These cases can only undergo delayed or interval cholecystectomy, although a small study (EL 1b [280]) suggested that a fully conservative treatment can be tried. In the acute phase, precutaneous cholecystostomy has been proposed as a means of alleviating symptoms until definitive treatment can take place (EL 1b [115]; EL 4 [20, 28, 31, 40, 47, 100, 126, 145, 213, 217, 288]). However, one randomized trial from Greece (EL 1b [109]) found that cholecystostomy and conservative treatment performed similarly well, thus justifying the use of both approaches in an individually tailored manner. On the other hand, the benefits of early surgery should not be generally denied to elderly or comorbid patients. With careful anesthesiologic and surgical management, satisfactory results can be achieved in these difficult subgroups (EL 2b [48]; EL 4 [219]).

Acute pancreatitis

Patients with acute biliary pancreatitis should undergo definitive management of gallstones during the same admission (GoR B). After assessment of severity, mild cases should be done within 2 weeks, whereas severe cases should be done when the general condition has significantly improved (GoR C). The bile duct should be imaged to ensure it is clear of stones (intraoperative cholangiography, magnetic resonance cholangiopancreatography, (MRCP), or endoscopic ultrasound) (GoR B).

Acute pancreatitis is a disease entity with manifold etiologies and large differences in clinical appearance but with high morbidity and mortality in more severe cases. Therefore, classification of acute pancreatitis according to severity is crucial for clinical management. Severe disease requires intensive care and CT imaging (EL 5 [195]). Laparoscopy for diagnostic reasons is unnecessary since diagnosis and classification can be based on other criteria and imaging results (EL 5 [34, 65]).

Early pancreatic necrosectomy compared to late or no surgery has been found to be detrimental in various studies (EL 1b [125, 182]; EL 2b[6, 19, 75, 108, 274]). Whenever possible, necrotic tissue should be allowed to demarcate over a few weeks before necrosectomy takes place. Although some situations (e.g. hemorrhage or compartment syndrome) render surgical exploration inevitable, the majority of cases with severe pancreatitis can and should be spared early surgery (EL 1b [167, 237]). If surgery is necessary, minimally invasive techniques can be chosen for exploration, irrigation, necrosectomy, and drainage (EL 2b [91]; EL 4 [107, 209, 297]), but the open approach is still considered the gold standard (EL 4 [195]).

In biliary pancreatitis, two different approaches may be chosen depending on disease severity. In mild biliary pancreatitis, early laparoscopic cholecystectomy with intraoperative cholangiography is the preferred approach (EL 1b [46, 227, 255]; EL 4 [114, 263]; EL 5 [30, 214]). Bile duct clearance is essential to prevent recurrent disease. Therefore, all patients with biliary pancreatitis should undergo definitive treatment at the next best opportunity, preferably during the same hospital admission. There are no studies available to compare a wait-and-see policy versus early removal of bile duct stones, but the risk of a potentially life-threatening recurrent pancreatitis when delaying bile duct clearance is generally considered to be unwarrantable.

There are three different options available to clear the bile duct: endoscopic stone extraction during endoscopic retrograde cholangiopancreatography (ERCP), laparoscopic exploration, and open exploration. Neither the 1998 EAES guidelines on common bile duct stones nor the 2005 UK guidelines on acute pancreatitis, favored one approach over the others (EL 5 [214, 275]). Because the scientific basis for these recommendations is unchanged, all three strategies are still equally recommendable. In general, surgery should only be started after the bile duct has been cleared, unless there is expertise available for intraoperative duct clearance (EL 2b [276]). If MRCP is available for imaging, it allows detection of choledocholithiasis with sensitivity and specificity both over 90% (EL 2a [124]), although the performance of MRCP may be inferior in acute pancreatitis. In most patients, a negative MRCP is sufficient to exclude bile duct stones, thus obviating the necessity of intraoperative clearance (EL 1b [106]). In conclusion, the optimal strategy in most hospitals will depend on the availability of imaging modalities, on the one hand, and surgical expertise with laparoscopic bile duct exploration, on the other hand.

Severe cases of biliary pancreatitis have a high risk of organ failure and death, which usually contraindicates early surgery. Again, bile duct clearance is necessary, but the timing and methods of definitive therapy are different than in mild disease forms. In severe cases, ERCP with or without endoscopic sphincterotomy followed by interval laparoscopic cholecystectomy is common (EL 1a [16]; EL 1b [76, 87, 200, 269], EL 4 [228]; EL 5 [1, 59]). After the publication of several diagnostic accuracy studies with good results (EL 1b [5, 42, 166, 221, 234]), the role of endoscopic ultrasonography (EUS) increased, but the advantage of EUS depends on the prior probability of bile duct stones (EL 2b [13, 229]). As already mentioned, disease classification is the cornerstone of successful therapy (EL 2b [201]). Several different systems have been proposed for defining a presumably severe case of pancreatitis and for describing the clinical course (Ranson score, APACHE II score, inflammatory markers, etc.), but the difficult choice of an optimal system is beyond the scope of these recommendations. The UK guidelines recommend delaying surgery ''until signs of lung injury and systemic disturbance have resolved,'' which aptly describes the subjective nature of this decision on timing.

Acute appendicitis

Patients with symptoms and diagnostic findings suggestive of acute appendicitis should undergo diagnostic laparoscopy (GoR A) and, if the diagnosis is confirmed, laparoscopic appendectomy (GoR A). If diagnostic laparoscopy shows that symptoms cannot be ascribed to appendicitis, the appendix may be left in situ (GoR B).

Appendicitis is a very common disease, but its symptoms are often equivocal and many other causative pathologies can be responsible. Despite improved imaging with sonography or CT, the rates of false-negative appendectomy are still high, especially in women (El 4 [29, 86]). Among the 56 randomized trials that have compared laparoscopic and conventional approaches for suspected appendicitis (EL 1a [233]; EL 1b [186]), only a few studies have explicitly used the findings of diagnostic laparoscopy to guide further surgical therapy. Most of these studies included only female patients of fertile age and documented a large reduction in the rate of negative appendectomy (EL 1b [37, 117, 147, 151, 205, 277]). However, the diagnostic advantages in men and children seem to be smaller and less consistent since appendicitis is much easier to diagnose in these subgroups.

The relative advantage of laparoscopic over conventional appendectomy has been under under debate for more than a decade. According to the most recent Cochrane Review (EL 1a [233]), laparoscopic appendectomy offers certain advantages, although the difference compared to open appendectomy is not major. The EAES guidelines on appendectomy clearly favor the laparoscopic approach (EL 5 [72]), mainly because of the significantly reduced risk of wound infection and the faster postoperative recovery. This recommendation also pertains to perforated cases.

If the appendix looks normal on laparoscopy but another pathology is found to be the cause of the patient's symptom, then the appendix should be left in situ (EL 4 [278]). The 10-year follow-up by van Dalen et al. (EL 1b [277]) demonstrated the safety of this approach in women. The situation is more complicated when the appendix shows no signs of inflammation and no other pathology can be found. Different groups have provided contradictory data on the reliability of macroscopic diagnosis of appendicitis (EL 4 [51, 103, 141, 266]). Weighing the disadvantage of a negative appendectomy against the risk of overlooking a case of appendicitis is difficult. If symptoms and signs are severe and typical for appendicitis, most surgeons will consider appendectomy to be indicated because in early appendicitis inflammation may be limited to intramural layers.

Acute diverticulitis

Patients with presumed acute uncomplicated diverticulitis should not undergo emergency laparoscopjc surgery (GoR C). Although colonic resection remains standard treatment for perforated diverticulitis, laparoscopic lavage and drainage may be considered in some selected patients (GoR C).

After physical examination and a blood count, CT is especially useful to diagnose diverticulitis. If complicated disease is likely, CT is able to visualize inflammation of the pericolic fat, thickening of the bowel wall, or peridiverticular abscess. Diagnostic laparoscopy is therefore unnecessary. Resection of the diseased segment should be performed in an elective rather than an emergency setting since the risk of conversion and the rate of primary reanastomosis strongly depend on the presence and severity of acute inflammation. The value of elective laparoscopic sigmoid resection has been addressed in guidelines issued by the EAES in 1999 [134].

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, and stage IIb Indicates complex abscess associated with or without fistula. Diffuse peritonitis is classified as stage III (purulent) or IV (fecal). Peritonitis or pneumoperitoneum usually require emergency surgical exploration (EL 1b [142, 294]; EL 5 (10, 212]). In Hinchey stages III and IV, laparoscopic abdominal exploration and peritoneal lavage have been successfully used, but there are only limited data available (EL 2b [77]; EL 4 [88, 206, 223, 235]). A laparoscopic approach may be especially advantageous in high-risk patients, who would probably not survive Hartmann's procedure. In such patients, perforation may be closed by an omental patch (EL 4 [88]). In stage IIb, abscesses can be drained and fistula can be closed laparoscopically (EL 4 [88, 223, 238]), but it must be taken into account that only very few surgeons are experienced enough to perform these operations. It is therefore too early to generally recommend laparoscopic emergency surgery for complicated diverticular disease, despite promising results.

Small bowel obstruction due to adhesions

In the case of clinical and radiological evidence of small bowel obstruction nonresponding to conservative management, laparoscopy may be performed using an open access technique (GoR C). If adhesions are found at lagaroscopy, cautious lajgaroscopic adhesiolysis can be attempted for release of small bowel obstruction (GoR C).

The clinical value and the potential complications of adhesiolysis are highly debated. A blinded trial by Swank et al. found similar levels of pain after diagnostic laparoscopy with or without adhesiolysis (El 1b [262]). Although this trial was performed in patients with chronic recurrent abdominal pain, it also has implications for the acute pain situation. On the other hand, laparoscopic adhesiolysis is sometimes performed at diagnostic laparoscopy for acute abdominal pain, to enable complete visualization of the abdominal content. Therefore, the term adhesiolysis covers a wide spectrum of invasiveness. Furthermore, the natural variability of adhesions and their sequelae determines possible success and failure rates of adhesiolysis. Therefore, the decision for adhesiolysis in the acute setting is a balance of these factors (EL 2b [284]). As a rule, adhesiolysis in an abdomen without intestinal obstruction should be kept to a minimum.

Radiographically confirmed small bowel obstruction requires emergency surgery (EL 2b [82–84] when nonoperative therapy is unsucessful. Laparoscopic treatment of acute small bowel obstruction was first described by Bastug et al. (EL 4 [18]) and has since been reported by others (EL 4 [3, 8, 17, 32, 55, 56, 89, 90, 111, 129, 160, 163, 197, 243, 254, 259, 261]). Studies comparing the results of laparoscopic and conventional treatment of this condition are nearly lacking, except for the matched-pair analysis by Wullstein and Gross (EL 2b [289]). The benefits of the laparoscopic approach that have been reported consist of a more rapid postoperative recovery with faster return of bowel movements, lower morbidity, and shorter hospital stay. However, there is concern that laparoscopic treatment of small bowel obstruction may lead to a higher rate of bowel injury than conventional surgery. In the single comparative study (EL 2b [289]), the risk of perforation was clearly higher in the laparoscopic group (27%). The high conversion rate is also an issue. Complete laparoscopic treatment seems to be possible in only 50%–60% of patients (EL 4 [3, 8, 17, 32, 55, 56, 89, 111, 129, 160, 163, 197, 243, 254, 259, 261]). The remaining patients have to be converted to open surgery for malignant disease, iatrogenic bowel perforation, or other reasons. Some studies have examined predictive factors for successful laparoscopy (EL 2b [163, 259]). A history of two or more surgical abdominal operations, late operation (>24 h), and bowel diameter exceeding 4 cm have been reported to be predictors of conversion. An isolated scar from a previous appendicectomy seems to be favorable in terms of avoiding a conversion. To avoid the possibility of intraabdominal injuries during laparoscopic access, open rather than laparoscopic surgery should be performed if scars or other findings indicate the presence of severe or extended adhesions (EL 4 [85, 192]).

Incarcerated hernia

Although the open approach remains standard treatment for incarcerated hernia, laparoscopic surgery may be considered in carefully selected patients (GoR C).

The available evidence for the use of laparoscopic surgery in inguinal, incisonal, and other hernias is very good, but all these studies have excluded symptomatic and emergency surgery cases. It seems unjustified to adopt the principle of transferable evidence to delineate the treatment of incarcerated hernia from the results obtained in the elective setting. With regard to the laparoscopic treatment of incarcerated hernias, so far only case reports (EL 4 [38, 58, 78, 123, 150, 164, 271, 283, 290]) and small case series (EL 4 [81, 113, 149, 154, 165, 239]) have been published. The largest series is from Leibl et al. (EL 4 [158]) and reports on 220 patients. The authors—highly experienced laparoscopic surgeons—found their results in incarcerated groin hernias to be similar to those elective for hernia repair. Because there are no comparative studies available to compare open and laparoscopic surgery, one should be very reluctant to choose a laparoscopic approach to hernia sac, abdominal wall, or peritoneum. Although early clinical results are promising, these techniques should be restricted to surgeons with maximum expertise in laparoscopic hernia surgery.

Mesenteric ischemia

If mesenteric ischemia is clinically suspected, conventional imaging is preferable over diagnostic laparoscopy in defining therapeutic management (GoR C).

Acute mesenteric ischemia is caused by arterial occlusion (approxiamately 50% of cases), nonocclusive arterial ischemia (20–30%), or venous occlusion (5–15%) [253]. A clinical diagnosis of mesenteric ischemia is usually confirmed by the use of conventional angiography, CT scanning, or duplex sonography [132, 204, 216]. Traditional surgical therapy consists of resection of infarcted bowel segments or embolectomy, depending on duration and extent of ischemia. The benefit of surgery needs to be considered on a case-by-case basis since there is no good evidence available to compare surgical and medical treatment for those patients with a salvageable condition (EL 2b [26, 68, 296]).

The potential value of emergency laparoscopy in these patients relates to its diagnostic rather than its therapeutic opportunities. However, the rate of mesenteric ischemia among patients with acute abdomen is only approximately 1% [112]. Furthermore, laparoscopic viewing does not guarantee correct recognition of ischemia. Since radiographic imaging accurately identifies most cases of mesenteric ischemia, it is very unlikely that diagnostic laparoscopy will prevent a negative laparotomy in these patients. In the literature, only a few cases have been published (EL 4 [52, 54, 73, 292]; EL 5 [159]), although there are more reports concerning second-look laparoscopies.

Gynecologic disorders

If gynecologic disorders are the suspected cause of abdominal pain, diagnostic laparoscopy should follow conventional diagnostic investigations (GoR A), and, if needed, a laparoscopic therapy for the disease should be performed (GoR A). A close cooperation with the gynecologist is strongly recommended.

Many acute gynecologic disorders can be approached safely and effectively by laparoscopy with the intent not only to correctly diagnose the patient but also to render treatment (EL 4 [138, 174, 196, 207]). The most common diagnoses encountered in women with acute pelvic pain are ectopic pregnancy (approximately 20% of cases), salpingo-oophoritis (20%), pelvic adhesions (20%), endometriosis (15%), and ovarian cysts (15%). In gynecological emergencies, CT scans are very seldom helpful. After a pregnancy test, transvaginal and conventional ultrasound can aid in formulating a differential diagnosis. However, diagnostic laparoscopy is superior to other diagnostic tools (EL 2b [183]) and may lead to the correction of an erroneous preoperative diagnosis in up to 40% of patients (EL 4 [7, 67, 138, 264]).

Ectopic pregnancy (EP) is a life-threatening condition. In early pregnant women presenting with acute pelvic pain and/or vaginal bleeding, a diagnostic laparoscopy should always be considered to exclude EP. In the vast majority of cases, a pregnancy test can exclude the diagnosis in cases with only minor symptoms. When serum human chorionic gonadotropin (hCG) levels reach 1,000 IU/L, transvaginal ultrasonography can differentiate between an EP or an intrauterine pregnancy (IUP) because all IUPs can clearly be seen in cases with hCG > 1,000 IU/L. A normal IUP will have a hCG doubling rate of 2 days. Thus, vaginal ultrasound and hCG go hand in hand in the diagnosis of EP in cases of minor or no abdominal symptoms (EL 5 [222]). In cases with EP, laparoscopic surgery should be undertaken also because of its total cost is cheaper (EL 1b [101]). 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 (EL 1b [171, 172, 279]; EL 2b [79, 189]). Laparoscopic salpingectomy should be performed in cases of ruptured tubal pregnancy. In cases of unruptured tubal pregnancy, a tube-preserving operation should be considered. Hemodynamic instability is a contraindication for laparoscopy.

Torsion of ovarian cysts is an organs-threatening disease. Patients often present with acute abdominal pain. After excluded pregnancy, a transvaginal ultrasound is mandatory to exclude ovarian cyst formation. In the majority of patients, free fluid can be seen in the abdomen, and if symptoms decline, an expectative attitude can be undertaken. In cases with persistent pain and/or if a larger cyst is seen on ultrasound, a diagnostic laparoscopy must be performed to exclude adnexal torsion. Ovarian cysts that are found during diagnostic laparoscopic should be treated laparoscopically (EL 1b [175, 291]). Pregnant women with acute pelvic pain and clinical signs of torsion of ovarian cyst should be offered laparoscopic repair. Laparoscopic surgery was also reported to be superior compared to open surgery for resecting other types of ovarian cysts (EL 1b [203]).

Endometriosis often causes infertility and pain. Pain is usually chronic and recurrent, but some patients present with acute symptoms. Surgical treatment may be indicated in some patients and may be performed as an open procedure or laparoscopically. Only one trial has compared the two approaches (EL 1b [175]) and documented a significantly faster and less painful recovery after laparoscopy. 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 (EL 1a [116]; EL 1b [1, 260]).

Salpingo-oophoritis commonly causes acute pelvic pain and often mimics other diseases. Conservative treatment consists of antibiotics. Laparoscopy is useful to exclude other pathologies, which may be present in approximately 20% of patients (EL 4 [22]). Furthermore, microbiological specimens can be taken to guide antibiotic therapy. Depending on the severity of symptoms, laparoscopy is therefore considered to be advantageous for acute salpingitis (EL 4 [22, 251]) and pyosalpinx (EL 4 [267]).

Nonspecific abdominal pain

Patients with severe nonspecific abdominal pain (NSAP) after full conventional investigations should underao diagnostic laparoscopy if symptoms persist (GoR A). Patients with NSAP of medium severity may undergo diagnostic laparoscopy after a period of observation (GoR C).

According to symptoms and diagnostic findings, most patients with acute abdominal pain can easily be categorized into different groups of presumed diagnoses, but some patients will not fit into these diagnostic categories due to unclear or equivocal findings. In. these cases, of NSAP, the severity of symptoms determines the necessity of emergency surgery. Some patients definitely require surgical exploration, a second group can safely be monitored under conservative therapy, and in a third group the decision between operative or conservative management is unclear. If symptoms are severe enough to require surgical exploration, this should be done laparoscopically. The reason lies more in the therapeutic than the diagnostic value of laparoscopic surgery. As described previously, laparoscopic surgery is advantageous for many intraabdominal diseases, which may also turn out to be the underlying cause of an unclear abdomen. Also, because converted cases have a similar outcome compared to primarily open cases (EL 2b [57]), the benefits of a laparoscopic approach outweigh its potential negative effects.

Four randomized controlled trials have compared early laparoscopy versus observation for nononspecific acute abdominal pain (Table 4). Three trials focused exclusively on right iliac fossa pain in women after excluding clear cases of appendicitis (EL 1b [43, 92, 187]). The fourth trial included 120 men and women with acute abdominal pain regardless of pain localization (EL 1b [64]). Three out of four trials found that early laparoscopy clearly facilitated the establishment of a. diagnosis with subsequent therapy, whereas more patients in the control group left the hospital without a clear diagnosis. More important, hospital stay was shorter in two of the trials (EL 1b [43, 92]). At 1-year follow-up, recurrent pain episodes were less frequent (EL 1b [187]) and health-related quality of life was better (EL 1b [64]) in the laparoscopic group. Based on these data, it seems justified to lower the threshold for surgical exploration when using a laparoscopic rather than an open approach. However, it seems advisable to observe patients over some hours because abdominal symptoms may become more specific over time or simply disappear in some cases (EL 4 [128]).

Abdominal trauma

For suspected penetrating trauma, diagnostic laparoscopy is a useful tool to assess the integrity of the peritoneum and avoid a nontherapeutic laparotomy in stable patients

Table 4. Randomized controlled trials comparing laparoscopic surgery and conservative management for acute nonspecific abdominal pain[a]

Study, year	LoE	No. of patients	Patients in conservative group receiving surgical exploration (%)	Patients remaining without a final diagnosis (%)	Difference in hospital stay (d)
Champault et al., 1993 [43]	1b	33/32	50	3/72	−2 sign.[b]
Decadt et al., 1999 [64]	1b	59/61	28	19/64	±0 n.s.[c]
Gaitán et al., 2002 [92]	1b	55/55	40	5/2	−1 sign.[b]
Morino et al., 2003 [187]	1b[d]	24/29	31	12/55	NA

LoE, level of evidence; NA, not assessed; n.s., not significant
[a] Data are shown for laparoscopic/conservative group. Studies are ordered according to year of publication
[b] Data are difference of means
[c] Data are difference of medians
[d] Only published abstract available

(GoR B). Stable patients with blunt abdominal trauma may undergo diagnostic laparoscopy to exclude relevant injury (GoR C).

Laparotomy for abdominal trauma used to be negative or nontherapeutic in approximately one-third of patients (EL 4 [162, 226]), but modern imaging techniques have reduced this figure to less than 10% (EL 4 [104]). The literature contains approximately 40 prospective or retrospective cohort studies on the diagnostic role of laparoscopy in trauma (EL 4 [281]). The major advantage of laparoscopy as identified in these studies was the obviation of unnecessary laparotomy in approximately 60% of cases. However, relevant injuries went undetected in 1% of all laparoscopies, particularly after blunt trauma affecting solid organs or hollow viscus (EL 4 [281]). Because the majority of the available evidence derives from patients with stab or gunshot wounds, diagnostic laparoscopy seems to be recommendable as a screening tool for patients with a moderate to high index of suspicion for intraabdominal injuries. However, in hemodynamically unstable patients, emergency surgical exploration of the abdomen may be life-saving. In this situation, delaying definitive therapy by laparoscopy is contraindicated.

Two randomized studies have been published on laparoscopy in trauma. A small study compared laparoscopy with peritoneal lavage and found higher diagnostic specificity in the laparoscopic group (EL 1b [63]). The second trial was, in fact, a double trial (EL 1b [161]). First, it compared exploratory laparotomy and diagnostic laparoscopy for stab wounds that had penetrated the peritoneum. Second, patients with equivocal peritoneal violation were randomized to diagnostic laparoscopy or expectant nonoperative management. Not unexpectedly, laparoscopy reduced hospital stay compared to laparotomy but prolonged hospital stay compared to conservative management (EL 1b [161]). Although laparoscopy saved more than half of patients from laparotomy, the postoperative clinical course and costs failed to differ between laparoscopic and laparotomic group. Because the study was relatively small and did not report on the potential long-term advantages of laparoscopy, further research is needed. Accordingly, the panel believes that the available evidence does not justify a high-grade recommendation.

Although the trials mentioned previously did not use laparoscopy for therapeutic reasons, it is clearly possible to treat certain injuries laparoscopically. Bleeding from minor injuries to the liver or the spleen can be controlled through the laparoscope (EL 4 [50, 53, 293]). Diaphragmatic lacerations (EL 4 [179, 248, 249]) and perforating stab wounds of the gastrointestinal tract can be sewn or stapled (EL 4 [53, 177, 293]). Nevertheless, the scarceness of clinical data prohibits a clear recommendation in favor of therapeutic laparoscopy for trauma.

Discussion

Available evidence clearly demonstrates the superiority of a laparoscopic approach in various emergency situations, but laparoscopy offers less or unclear benefit in other acute conditions. Therefore, a policy of laparoscopy for all patients with acute abdominal pain still seems unjustified, although laparoscopy will be to the advantage of the majority of patients. The initial usage of diagnostic procedures and imaging should aim to identify those patients who would probably not benefit from laparoscopy. On the other hand, it usually carries only minor disadvantages for a patient if a diagnostic laparoscopy has to be converted to an open procedure. Because the current guidelines deal with complex laparoscopic procedures, a low threshold toward early conversion is generally useful in order to avoid delays in the operating room.

Although the current recommendations address the most common diagnoses, some less prevalent causes of acute abdominal pain were not specifically discussed. Some of the more rare diagnoses were encountered in the cohort studies summarized in Table 1. These diseases include abdominal abscess, peritoneal tuberculosis, and intestinal volvulus. Due to their low occurrence, these diseases will probably never be studied in a randomized trial, but their relative importance in the treatment of an average patient is low. Laparoscopic therapy has been described to be useful for many of these conditions (EL 2b [265]; EL 4 [9, 127, 245]).

The panel also decided not to prepare separate recommendations on the usage of laparoscopy in children with acute abdominal pain. The disease spectrum of

pediatric acute abdominal pain is completely different compared to that of adults, but older children and adolescents are good candidates for laparoscopy (EL 4 [118, 287]). The value of specific procedures in pediatric surgery, such as laparoscopic appendectomy, is still under intensive debate. In consequence, these guidelines are valid only for adult patients. Also, there was no pediatric surgeon on the panel to define the possible role of laparoscopic surgery for pyloric stenosis, congenital malformations, and other disorders of the newborn or small child.

Future research should concentrate on those fields. for which only low-level evidence is available. The current guidelines have identified some topics that have been described only in feasibility studies. It is highly desirable to supplement these studies with additional comparative data on effectiveness and cost-effectiveness. 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, laproscopic surgery has been shown to be highly beneficial. Therefore, optimism with regard to laparoscopy may prove to be justified Laparoscopy has already had a major impact on the management of abdominal emergencies and has become an indispensable technique.

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