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Laparoscopy in Abdominal Emergencies.
Romanian Association for Endoscopic Surgery Consensus. Part I (Trauma)

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Rezumat

Laparoscopia în urgențele abdominale.
Consensul Asociației Române de Chirurgie Endoscopică. Partea I (Trauma)

Introducere: laparoscopia a apărut ca un instrument esențial în gestionarea patologiilor abdominale acute. Oferă avantaje diagnostice şi terapeutice, permițând chirurgilor să evalueze şi să abordeze diverse afecțiuni abdominale acute prin tehnici minim invazive.

Acest consens îşi propune să ofere un ghid minimal pentru chirurgii care utilizează laparoscopia în situații de urgență.
Material şi Metode: într-un prim pas a fost înființat grupul de lucru al Comitetului de cercetare RAES şi s-a stabilit un grup de experți. S-a efectuat o revizuire a literaturii de specialitate în bazele de date medicale disponibile (Pubmed, Cochrane, EMBASE) şi a fost definit un set de întrebări legate de utilizarea laparoscopiei în urgențe traumatice şi non-traumatice. Validarea setului de întrebări a fost făcută de grupul de experți într-o primă rundă Delphi. Au fost formulate recomandări în urma consensului, iar calitatea dovezilor şi a recomandărilor au fost evaluate cu sistemul GRADE. Recomandările au fost formulate într-o manieră cat mai simplă şi apoi evaluate de grupul de experți utilizând tehnica Delphi pentru obținerea consensului.
Rezultate: au fost evaluate două tipuri principale de urgențe, traumatice şi non-traumatice. S-au formulat 7 recomandări pentru secțiunea de traumă. Fiecare recomandare a avut acordul grupului de experți. Recomandările au inclus instruirea chirurgilor implicați în urgențele traumatice, indicațiile şi contraindicațiile laparoscopiei în cazurile de traumă, conversia şi complicațiile laparoscopiei în traumatisme.
Concluzii: consensul RAES oferă un set de linii directoare pentru chirurgii care gestionează afecțiunile abdominale acute utilizând tehnicile laparoscopice.

Cuvinte cheie: laparoscopie, chirurgie de urgență, abdomen acut

Abstract

Background: laparoscopy has emerged as a pivotal tool for the management of acute abdominal pathologies. It provides diagnostic and therapeutic advantages, enabling surgeons to evaluate and address diverse acute abdominal conditions using minimally invasive techniques. The aim of this consensus was to obtain evidence-based guidance for surgeons regarding the utilization of laparoscopy in emergency medical settings, and has been divided into trauma and non-trauma emergencies. This is the part dedicated for trauma.
Material and Methods: the task forces of the RAES Research Committee and a panel of experts were established. The development of consensus statements started with an extensive literature review of available medical databases (PubMed, Cochrane, and EMBASE). A set of questions addressing major issues related to the use of laparoscopy in trauma and non-trauma emergencies was defined. The validation of the questions set was performed by the expert group through the first Delphi round. Consensus statements and recommendations were also obtained. The quality of evidence and recommendation strength were rated using the GRADE system. The recommendations were formulated in a directive manner and then assessed by an expert panel using the Delphi technique for agreement.
Results: the two main types of emergencies were trauma and non-trauma. There were seven recommendations for the trauma section. For each statement, agreement from the expert panel was obtained. The statements included training for surgeons involved in trauma care, indications and contraindications for laparoscopy in trauma cases, and conversions and complications of laparoscopy for trauma.
Conclusions: the RAES consensus offers a set of guidelines for surgeons managing acute abdominal conditions using laparoscopic techniques.

Key words: laparoscopy, emergency surgery, acute abdomen

Introduction

In recent years, significant progress has been made in the field of minimally invasive surgery, which is also referred to as laparoscopic surgery. These advancements have transformed the landscape of surgical procedures, leading to improved surgical outcomes, including reduced postoperative pain, better visualization of the operative site, and lower complication rates, thereby establishing laparoscopic techniques as the preferred choice across various surgical disciplines (1-3). Studies have demonstrated that laparoscopic approaches, particularly when implemented within enhanced recovery programs, can significantly reduce hospital stay durations compared to traditional open surgeries while maintaining comparable morbidity and quality of life outcomes for patients undergoing such procedures (4). Furthermore, the evolution of laparoscopic techniques continues to challenge previously accepted surgical principles, suggesting that the ongoing development of instruments and methodologies may further enhance the capacity for successful intervention in complex surgical cases.

Although the use of laparoscopy in emergency settings has clear benefits, it is important to recognize the unique challenges posed by these scenarios. Factors such as limited time, accessibility of equipment, and availability of skilled surgical personnel can impede successful implementation of laparoscopic techniques. However, even in rural or resource-limited settings, laparoscopy remains beneficial (5). There is a growing body of evidence regarding the use of laparoscopy in abdominal emergencies, highlighting its potential to enhance patient outcomes and reduce the overall burden of these conditions (6). Research has shown that laparoscopic techniques can be particularly beneficial in managing acute complicated appendicitis and gangrenous cholecystitis, thereby leading to improved recovery profiles and reduced postoperative morbidity (7). Moreover, advancements in laparoscopic technology have expanded its application to include complex scenarios, such as perforated peptic ulcers, where laparoscopic intervention not only aids in diagnosis but also allows for direct repair and thorough peritoneal lavage. For the patient, this translates into decreased pain, faster return to work, and improved overall quality of life.

Furthermore, the dual functionality of laparoscopy in the diagnosis and treatment of abdominal trauma highlights its importance. This technique can effectively detect hidden injuries while concurrently enabling interventions to address these problems, thereby reducing the need for more invasive procedures. The integration of minimally invasive techniques can substantially decrease the rate of negative laparotomies and associated complications among suitable patients (8). As this field progresses, it is essential for surgeons to receive specialized training in advanced laparoscopic techniques to ensure they can achieve optimal outcomes comparable to those of traditional surgery, as the success of these operations is contingent on mastering specific skills that differ significantly from open procedures

The aim of the present consensus, as an initiative of the Romanian Association for Endoscopic Surgery (RAES), is to establish an updated set of guidelines regarding laparoscopy for those involved in emergency surgery.

Material and Methods

Study Design

In October 2023, at the RAES meeting, the absence of a national guideline framework for surgeons involved in treating abdominal emergencies was noted. As such, the decision to elaborate on a consensus regarding laparoscopy techniques in abdominal emergencies was made. The RAES Committee of Research created a task force. Then, a panel of experts from centers with high-volume laparoscopy cases and involved in emergency care was vetted. The Delphi method was used to reach consensus among the expert panel.

A preliminary literature search was conducted, and the main topics of traumatic

and non-traumatic abdominal emergencies were sought. The task force was elaborated on using an initial set of 88 questions. Following the initial exploratory Delphi round, the expert panel reached consensus on 47 questions. A comprehensive literature search on each topic was then performed using PubMed and EMBASE. The GRADE system was used to rate the quality of evidence (*Table 1*) (9). The authors generated statements and recommendations addressing each topic question based on their literature review, using the GRADE system. The recommendation strength was considered "strong" or "weak" (10). A strong recommendation means that the panel is confident that the desirable effects of adherence to the recommendation outweigh the undesirable effects (10). A weak recommendation means that the desirable effects on adherence to the recommendation outweigh the undesirable effects, but the panel is less confident (10).

The Delphi technique, with its four characteristics (anonymity, iteration, controlled feedback, and statistical aggregation of group response), was used for consensus among the expert panel regarding all recommendations (11). The expert panel members voted anonymously for each recommendation, choosing from five possible options (1. totally agree, 2. partially agree, 3. partially disagree, 4. totally disagree, 5. do not know), and provide brief comments if deemed necessary. Statements and recommendations were approved only upon achieving over 70% consensus among the expert panel, who totally or partially agreed with the statement. In cases of disagreement, the statement was modified following the discussion. The third round was initiated in September 2024 to complete and review the data.

Definitions

Abdominal trauma was defined as injury to the abdomen, further divided into open [penetrating abdominal trauma (PAT)] or closed trauma [blunt trauma (BT)].

Negative laparotomy: No abdominal injuries were identified on exploration.

Non-therapeutic laparotomy: An injury is identified but does not require intervention.

Non-traumatic abdominal emergencies refer to acute abdominal pain defined as any moderate or severe abdominal pain lasting less than seven days (12).

Inclusion Criteria

The inclusion criteria for the consensus were systematic reviews, randomized clinical trials, cohort studies, and case series with more than 10 patients, depending on the topic.

Exclusion Criteria

Animal studies, narrative reviews, and commentaries were excluded. A literature search yielded 683 studies on trauma.

Further queries were made to address this specific question.

The search strategy for the trauma topic included MeSH headings, as shown in *Table 2*.

The task force members had specific topics, and queries and article screening were performed for every question vetted by the panel in the preliminary round.

The senior members of the task force provided an overview of these topics and queries.

The recommendations are presented in *Table 3*.

Table 1. GRADE system on rating quality of evidence and strength of recommendations [after Guyatt GH et al. (9)]

Quality of evidence and definitions	
Further research is very unlikely to change our confidence in the estimate of effect	High quality
Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate	Moderate quality
Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate	Low quality
Any estimate of effect is very uncertain	Very low quality

Table 2. Search terms for the trauma topic

Search stages	Query terms	Search details	Results (no. articles retrieved)
1	"minimally invasive surgical procedures" (MeSH Terms) OR minimally invasive surgery (Text Word)	"minimally invasive surgical procedures" (MeSH Terms) OR "minimally invasive surgery" (Text Word)	633,391
2	"laparoscopy" (MeSH Terms) OR laparoscopy (Text Word)	"laparoscopy" (MeSH Terms) OR "laparoscopy" (Text Word)	141,070
3	"abdominal Injuries/classification" (Mesh) OR "abdominal Injuries/complications" (Mesh) OR "abdominal Injuries/etiology"	"abdominal injuries/classification" (MeSH Terms) OR "abdominal injuries/complications" (MeSH Terms) OR "Abdominal Injuries/etiology" (All Fields)	6,554
4	[("abdominal Injuries/classification" (Mesh) OR "abdominal Injuries/complications" (Mesh) OR "abdominal Injuries/etiology" (Mesh) OR "abdominal Injuries/mortality" (Mesh) OR "abdominal Injuries/physiopathology" (Mesh) OR "abdominal Injuries/surgery" (Mesh)] AND "Laparoscopy" (Mesh)	("abdominal injuries/classification" (MeSH Terms) OR "abdominal injuries/complications" (MeSH Terms) OR "abdominal injuries/etiology" (MeSH Terms) OR "abdominal injuries/mortality" (MeSH Terms) OR "abdominal injuries/physiopathology" (MeSH Terms) OR "abdominal injuries/surgery"(MeSH Terms)) AND "Laparoscopy" (MeSH Terms)	689

Results and Discussion

Q1: What specialized training is required for surgeons to perform laparoscopic interventions in trauma cases?

Training in laparoscopic surgery is essential because it requires specific perception and motor abilities that are more difficult to master than in open surgery (13,14). Formal training reduces the learning curve and time to aquire the necessary skills with clear benefits for the patient (e.g. reduced number of complications, reduced length of stay) (15-17). Training in laparoscopic surgery is well established through comprehensive national and international programs owing to the distinct differences between laparoscopic and open surgical techniques (17,18). There is an overall reduction in trauma incidents in various countries, and many cases benefit from non-operative treatment of trauma (19). As such, surgeons have less exposure to trauma cases and also to a more intensive and efficient formal trauma training (20,21). The

Table 3. Recommendations for laparoscopy in trauma

No.	Recommendation	Evidence and grade of recommendation	Agreement level
1	Laparoscopy for trauma should be performed by a surgeon with experience in laparoscopic surgery.	Level of evidence: low, Grade of recommendation: strong	100%
2	For hemodynamically stable patients with abdominal trauma, laparoscopy presents a viable and secure surgical approach.	Level of evidence: high, Grade of recommendation: strong	100%
3	The main contraindications for laparoscopy in trauma patients are hemodynamic instability, involvement of more than one organ, and coexistence of craniocerebral trauma.	Level of evidence: moderate, Grade of recommendation: strong	100%
4	Currently, there are no studies highlighting critical points in laparoscopy performed in trauma when indicated, except for the method of performing pneumoperitoneum.	Level of evidence: low, Grade of recommendation: low	100%
5	The main cause of conversion is bleeding. Because of the potential for massive bleeding, the conversion threshold should be very low especially when signs of hemodynamic instability occur.	Level of evidence: low, Grade of recommendation: strong	90%
6	It is reasonable to estimate that the rate of procedure-related complications is similar to or close to that of non-traumatic surgery, as there are no studies regarding this topic.	Level of evidence: low, Grade of recommendation: low	90%
7	Potential complications of laparoscopy performed in trauma are related to access to the peritoneal cavity (visceral and vascular injuries), pneumoperitoneum (intravascular gas embolism, hemodynamic instability, pneumothorax, subcutaneous emphysema), or omitted injuries.	Level of evidence: low, Grade of recommendation: low	100%

incorporation of laparoscopy into the management of traumatic conditions has made the need for effective skill acquisition and retention even more paramount as trauma surgeons are not necessarily trained in laparoscopy. There is no formal training program for laparoscopy in patients with trauma. Some programs for laparoscopic training include diagnostic laparoscopy. When such a program is implemented, increases in competence and proficiency are demonstrated (22). In a study by Matsevych et al., essential laparoscopic skills were camera navigation, mobilization of intra-abdominal organs, bowel run, and intracorporeal suturing, and a senior resident was involved in 19% of operations for trauma (23). In the same study, trauma constituted 16% of all laparoscopies performed. In another multicenter study, surgeons performing laparoscopy in trauma patients had at least 24 months of experience performing laparoscopic surgery in patients with other types of diseases (24). This could explain the better results presented by the authors (i.e., no missed injuries).

Recommendation 1: Laparoscopy for trauma should be performed by a surgeon with experience in laparoscopic surgery. (Level of evidence: low, Grade of recommendation: strong)

Q2: Is laparoscopy indicated in open/closed trauma?

Emergency exploratory laparotomy is a save-life technique employed when intra-abdominal injury is suspected, especially in blunt trauma (25). The presence of shock, hemodynamic instability, signs of severe internal bleeding (hypotension, increasing pulse rate, palor), explosive wounds (mines, grenades), thoraco-abdominal wounds, evisceration, impalement wounds, penetrating anal/vaginal wounds mandates emergency laparotomy (26,27). There are some debatable indications that mostly include stable trauma patients, including both blunt and penetrating trauma (26). Blunt abdominal trauma poses significant management challenges, as the injuries may not be readily apparent and the indications for exploratory laparotomy are less clear-cut compared to PAT (28). Historically, the negative laparotomy rate, where no significant injuries are found during exploratory surgery, has been reported to exceed 30% in some studies, with even higher rates noted in certain publications (29,30). Exploratory laparotomy has a complication rate between 22-61% (30,31). Thus, it must be avoided. Although the increased accuracy of ultrasound and CT scans has reduced the negative laparotomy rate, the range still varies significantly, from as low as 3.9% to as high as 36%; however, we must acknowledge that these data come from single-center reports (30,32). Laparoscopy has been gradually explored as a diagnostic modality for patients with blunt or penetrating abdominal trauma, provided they are hemodynamically stable (33-35). Delayed laparoscopy has also been used as a non-operative treatment for blunt trauma (36). The indications for exploratory laparoscopy were similar to those for laparoscopy. In PAT cases, confirmation of peritoneal penetration typically requires surgical exploration. Another indication for laparoscopy is suspected diaphragmatic injury with equivocal radiological examination (37). Exploratory laparoscopy has been indicated in patients with blunt abdominal trauma, unexplained free fluid or air on CT imaging, suspicion of diaphragmatic injury, or concerning clinical findings (34,38-41). Furthermore, it is possible to treat injuries laparoscopically, making laparoscopy a therapeutic option. Systematic reviews and meta-analyses showed high sensitivity and specificity of exploratory laparoscopy in trauma, leading to a significant reduction in negative and non-therapeutic laparotomies for both blunt and penetrating trauma (24,42,43). The primary advantage of laparoscopy is the avoidance of unnecessary laparotomy. In a systematic review combining studies, 1,340 patients were treated with non-therapeutic laparotomy (51.8%) (44). In another systematic review, laparoscopy in PAT was 100% sensitive in most of the included studies and avoided non-therapeutic laparotomies in 45.6% of the

patients (45). Therapeutic laparoscopy in trauma is associated with lower rates of wound infection and pneumonia and a comparable or shorter length of stay (45-47). Laparoscopic interventions may result in reduced operative duration and shorter hospital admissions for patients with both penetrating and blunt traumatic injuries (48, 49). Employing exploratory laparoscopy in trauma cases offers the advantage of significantly lower variable and total costs (50,51). Missed injuries remain a problematic aspect of performing laparoscopic procedures in trauma cases. Previous research has shown a rate of missed injuries of up to 41% per patient (52). However, recent advancements, particularly in equipment and surgical expertise, have resulted in a lower incidence of missed injuries in most recent studies (0–2%) (40,53-56). Nevertheless, negative laparoscopic findings do not completely rule out the possibility of a bowel injury. Clinical suspicion should be used to guide further evaluation and management.

Recommendation 2: For hemodynamically stable patients with abdominal trauma, laparoscopy presents a viable and secure surgical approach. (Level of evidence: high, Grade of recommendation: strong).

Q3: What are the laparoscopic contraindications for trauma?

The contraindications of exploratory laparos-copy for trauma include those specific to the procedure and those that are trauma-related, such as uncorrected coagulopathy, cardio-pulmonary compromise, evisceration, certified intra-abdominal injuries not amenable to therapeutic laparoscopy, inability to access the peritoneum (e.g., associated burns), and multiple intra-abdominal adhesions. The main contraindication for exploratory laparoscopy in trauma management is hemodynamic instability (defined by most studies as a systolic pressure < 90 mmHg) (57).

The presence of shock, obvious or known abdominal lesions, and multiple organ/region injuries are other clear contraindications for laparoscopy in trauma (28,33,58,59). Hyper-capnia can easily occur during laparoscopic procedures, because CO2 is almost completely excreted through the lungs. Respiratory acidosis and increased CO2 output can last for more than one hour post-operatively (60). Elevated IAP and abdominal expansion shift the diaphragm cephalad and increase thoracic pressure, which can be deleterious to thoracic trauma. Carbon dioxide can get into the intrapleural space through diaphragmatic injuries and further compromise ventilation through tension pneumothorax (61). Neuro-logical trauma is another formal contraindication to laparoscopy. It has been documented that CO2 pneumoperitoneum necessary for laparoscopy increases intracranial pressure, making the procedure prohibited in cases of craniocerebral trauma (60). Limited laparos-copic experience is also a contraindication for trauma laparoscopy (57).

Recommendation 3: The main contraindications for laparoscopy in trauma patients are hemodynamic instability, involvement of more than one organ, and coexistence of cranio-cerebral trauma. (Level of evidence: moderate, Grade of recommendation: strong)

Q4: What are the critical points in laparoscopy for trauma?

Deciding when to perform laparoscopy during trauma is the most critical point of the procedure. Besides a correct indication prerequisites for laparoscopy are hemodynamic stability, absence of indications for urgent laparotomy, or intracranial trauma (47,59). The critical technical points are as follows:

- Entry into the peritoneal cavity (open methods are favored, although the evidence is of low quality) (62).
- Patients should be positioned in different ways to allow for the best possible visualization during the procedure.
- Positioning of the trocars: This point is related to a specific type of trauma (blunt or penetrating) and suspected organ involvement.

- Systematic exploration of the abdominal cavity, including the diaphragm. In PAT, exploration should visualize a possible peritoneal breach (41,63). Hemoperitoneum should be immediately assessed, and active hemorrhagic bleeding should be examined. In this last scenario the surgeon should have a low threshold for conversion (64,65).
- Thorough examination of the small bowel and the mesentery and of the large bowel using the correct technique (26) (59). Missed bowel injuries increase complication and mortality rates (66).
- After exploration, the decision to continue laparoscopically or by celiotomy can be made depending on the injury.

Recommendation 4: Currently, there are no studies highlighting critical points in laparos-copy performed in trauma when indicated, except for the method of performing pneumo-peritoneum. (Level of evidence: low, Grade of recommendation: low)

Q5: When is conversion during laparoscopy for trauma performed?

Another issue with laparoscopy in trauma is conversion. The conversion varies from 9.7-29.3% (55,67,68). The reasons for conversion from laparoscopy in trauma cases differ. For some authors, identification of an injury during exploratory laparoscopy mandates conversion. Other reasons for conversion include hemorrhage, hemodynamic instability or more than one injury detected, severe peritonitis, failure of equipment, visualization problems, and complex injuries (24,64, 67,69,70).

Recommendation 5: The main cause of conversion is bleeding. Because of the potential for massive bleeding, the conversion threshold should be very low especially when signs of hemodynamic instability occur. (Level of evidence: low, Grade of recommendation: strong)

Q6: What are the risks of procedure-related injuries during laparoscopy for trauma?

No relevant studies have been conducted on this topic in trauma. Early reports showed that entry injuries occur in 0.3-1.0% of laparoscopic procedures, with a mortality rate of 0-7 per 100,000 (71). IIntestinal injuries were reported between 0.6-2.7 per 1000 cases and 0.1 per 1000 for vascular injuries (72). More recent surveys of laparoscopic procedures indicate that entry access injuries occur at a low rate, ranging from 5 out of every 10,000 procedures to 3 out of every 1,000 procedures (73). There are no clear reports of entry injuries during laparoscopy for trauma. Therefore, the risk of entry injuries is similar to that of elective laparoscopy. To avoid this type of complication, the open entry technique was introduced (open entry, Hasson technique, direct vision, radially expanding (STEP) trocars, etc.). Comparing entry methods a recent Cochrane systematic review concluded: "Overall, evidence is insufficient to support the use of one laparoscopic entry technique over another. The results showed the advantage of direct trocar entry over Veress needle entry for failed entry. Most of the evidence is of very low quality…" (62). However, it must be noted that major vascular injuries occur most often with the Veress needle, which also increases the risk of fatal carbon dioxide embolism (60). However, it must be noted that major vascular injuries occur most often with the Veress needle, which also increases the risk of fatal carbon dioxide embolism

Recommendation 6: It is reasonable to estimate that the rate of procedure-related complications is similar to or close to that of non-traumatic surgery, as there are no studies regarding this topic. (Level of evidence: low, Grade of recommendation: low).

Q7: What are the complication rates associated with laparoscopy, in the context of trauma?

Complications in trauma laparoscopy can be related to the procedure or injuries and

techniques employed. The specific complications recorded in laparoscopy can be classified as entry related (see above, Q6), due to carbon dioxide insufflation to obtain pneumoperitoneum (PP), and postoperatively.

A serious but rare complication of PP is carbon dioxide embolism, with a mortality rate of up to 28% (74). A review of 489,335 closed laparoscopic procedures reported the incidence of carbon dioxide embolism to be approximately 0.001%. Carbon dioxide embolisms can occur at any point during laparoscopic procedures if there are intravascular openings with a pressure lower than the intra-abdominal pressure. In trauma, the risk of embolism may be higher in the presence of a possible abdominal vessel injury. Patients with hepatic trauma may be at higher risk, as gaseous embolism is most frequently reported in laparoscopic liver surgery (75-78).

Postoperative complications did not differ from those of non-trauma surgery. In a recent study comparing laparoscopy with conventional laparotomy with matching, there was no statistical difference between the two methods in terms of postoperative complications (6/54 (11.1%) vs. 9/54 (16.7%)) (24). Missed injuries are an important issue in trauma surgery. Although higher numbers of missed injuries were reported at the beginning of laparoscopy, the omitted injury rate for trauma laparoscopy was between 0.4-1%. This is comparable with the missed injuries rates of laparotomy (24,79).

Recommendation 7: Potential complications of laparoscopy performed in trauma are related to access to the peritoneal cavity (visceral and vascular injuries), pneumoperitoneum (intravascular gas embolism, hemodynamic instability, pneumothorax, subcutaneous emphysema), or omitted injuries. (Level of evidence: low, Grade of recommendation: low).

Conclusions

The guidelines presented herein are intended to serve as a supplementary resource to inform decision-making, but should not replace the surgeon's clinical judgement when addressing specific patient scenarios.

Conflict of Interest

Nothing to disclose.

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