CASE REPORT

The Role of Laparoscopic Surgery in Abdominal Trauma: A Case Report and Review

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ABSTRACT

Background: Abdominal trauma accounts for approximately 15 % of trauma admissions and remains a leading cause of preventable mortality. Traditionally managed by exploratory laparotomy of which up to 40 % are non-therapeutic the paradigm has shifted toward minimally invasive approaches. Laparoscopy now demonstrates diagnostic accuracy rates of 96–98 % and enables therapeutic repair in hemodynamically stable patients, resulting in reduced morbidity, infection rates, and length of stay. Case Presentation: A 23-year-old male sustained blunt abdominal trauma following a motorbike accident. He was hemodynamically stable with a positive FAST scan and CT evidence of hemoperitoneum and mesenteric contusion without solid-organ injury. Diagnostic laparoscopy revealed 6.3 L of hemoperitoneum and a through-and-through mesenteric tear 20 cm proximal to the ileocecal junction. Hemostasis was achieved using V-Loc 2.0 sutures with peritoneal lavage and drain placement. One unit of PRBC was transfused. Postoperatively, hemoglobin rose from 7.6 to 12.0 g/dL and CRP fell from 64 to 21 mg/L. The patient tolerated oral intake within 24 h and was discharged on day 4 without complications. Discussion/Review: Non-therapeutic laparotomies decreased by 58%, postoperative complication rates decreased by four times, and hospital stays decreased from 10.8 to 3.9 days, according to a targeted literature review (2020–2025; 24 studies). Conclusion: Laparoscopy should be a mainstay of contemporary trauma therapy since it provides therapeutic benefit and diagnostic accuracy in stable trauma patients, lowering hospitalization and morbidity.

Keywords: Laparoscopy; Abdominal Trauma; Diagnostic Laparoscopy; Blunt Trauma; Penetrating Injury; Minimally Invasive Surgery.

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INTRODUCTION

As the fourth most common cause of death globally and the leading cause of death for people under 45, trauma remains a significant global health burden. The World Health Organization (WHO, 2024) estimates that trauma kills 4.4 million people a year, more than the combined deaths from HIV, TB, and malaria. Abdominal involvement is one of the most common preventable causes of death for patients with polytrauma, accounting for 9–15% of all trauma-related presentations [1, 5, 24]. There are two main categories of abdominal trauma: penetrating and blunt. Each has unique consequences for diagnosis and treatment. Despite advancements in imaging, diagnosis can be difficult because blunt trauma, which is most frequently caused by motor vehicle crashes, falls, or industrial injuries, can disguise visceral or mesenteric injury beneath an unbroken abdominal wall. On the other hand, in order to prevent disastrous delays, penetrating trauma which is frequently caused by stab or bullet wounds requires quick evaluation of peritoneal breach, bleeding, and hollow-viscus injury. Occult injuries and non-therapeutic laparotomies continue to be issues in both patterns; according to historical statistics, up to 40% of exploratory laparotomies are classified as non-therapeutic [10, 19]. However, the surgical community sought less invasive solutions due to the associated morbidity, which included incisional hernia, adhesions, ileus, and wound infection.

Laparoscopy, which was first used in the 1980s, has gradually changed how trauma is managed. It was first used for diagnostic reasons and showed almost complete accuracy in detecting intra-abdominal injuries in individuals who were hemodynamically stable [8]. Its use has grown over the next decades from simple diagnosis to, in certain situations, definitive therapeutic intervention due to technological advancements in high-definition optics, bipolar energy systems, and hemostatic drugs [3–5, 8]. Laparoscopy has established itself as a viable alternative for trauma patients who are stable or stabilized due to its advantages, which include less postoperative pain, a decreased risk of infection, less transfusion needs, and better cosmetic results [11, 22, 24]. Current guidelines now advocate a laparoscopic-first approach for stable or transiently responsive trauma patients [2]. The care of mesenteric damage after blunt abdominal trauma is thus demonstrated in this case, which is followed by a narrative synthesis of recent data demonstrating laparoscopic's growing use in trauma surgery. The main research question is: When compared to open laparotomy, does laparoscopic surgery improve postoperative recovery, decrease non-therapeutic laparotomies, and increase diagnostic accuracy in hemodynamically stable abdominal trauma patients? **Literature Search**

To support the case that was presented and investigate the most recent data about the use of laparoscopic surgery in cases of abdominal trauma, a targeted literature research was carried out. Transparency and repeatability were guaranteed by the PRISMA narrative review methodology used in the search. Three electronic databases: PubMed, Google Scholar, and ScienceDirect were searched for articles published between January 2020 and October 2025. The terms "diagnostic laparoscopy," "therapeutic laparoscopy," "abdominal trauma," and "laparoscopic surgery" were used in different combinations. Every article that was obtained was imported into Zotero for reference management and screening. A total of 1,078 articles were filtered based on the relevancy of the title and abstract after duplicates were eliminated. For full-text evaluation, studies that concentrated exclusively on adult patients with penetrating or blunt abdominal trauma treated laparoscopically were kept. After a thorough assessment, 24 of the 32 papers that satisfied the inclusion requirements were chosen. Only English-language, peer-reviewed publications were included. Reviews, meta-analyses, case reports, and cohort studies that addressed the therapeutic or diagnostic results of laparoscopy were deemed pertinent. Animal or experimental models, non-trauma emergency laparoscopy, and pediatric investigations were not included.

Case Presentation

Patient Information

A 23-year-old man who had suffered traumatic abdominal damage in a motorcycle fall arrived at the emergency room of Thumbay University Hospital in Ajman on September 29, 2025, with acute, widespread abdominal pain. There was no outward bleeding, vomiting, or loss of consciousness. The patient had no significant past medical or surgical history and was not using any regular drugs. It was found that his blood type was O positive.

Clinical Findings

On admission, the patient was hemodynamically stable, with a blood pressure of 112/74 mm Hg, heart rate of 74 bpm, respiration rate of 18/min, temperature of 36.8 °C, and SpO_2 99 % on room air. A physical examination revealed mild stomach distension, generalized pain, and regional guarding in the left lower quadrant. Bowel sounds could be heard, and neither ecchymosis nor laceration were observed. Initial laboratory evaluation revealed Hb 7.6 g/dL, Hct 22.60%, WBC 11.2 × 10^9/L, Platelets 220 × 10^9/L, and CRP 64.3 mg/L, indicating anemia and an inflammatory response. Serum creatinine was 1.0 mg/dL, eGFR 92 mL/min/1.73 m^2, ALT 18 U/L, AST 31 U/L, sodium 135.3 mmol/L, potassium 4.6 mmol/L, and total bilirubin 0.86 mg/dL, all within normal limits. The pelvic cavity was found to contain free fluid by Focused Assessment with Sonography for Trauma (FAST). Contrast-enhanced CT (CECT) of the abdomen and pelvis demonstrated free fluid in the peritoneal cavity, predominantly in the perihepatic, perisplenic, bilateral

iliac fossae, and pelvic regions, consistent with hemoperitoneum. The post-contrast phase revealed active extravasation of intravenous contrast in the right iliac fossa, with fat stranding and fluid streaking in the adjacent mesentery findings indicative of a mesenteric vascular injury likely involving the ileal branches of the superior mesenteric artery. Delayed images confirmed contrast pooling at the same site. All solid organs (liver, spleen, pancreas, kidneys, and adrenals) were normal in size and attenuation, with no evidence of bowel perforation, pneumoperitoneum, or retroperitoneal hematoma. The appendix, urinary bladder, and prostate appeared normal (Figure 2). A screening chest X-ray (PA view) revealed clear lung fields, normal diaphragmatic outlines, and no evidence of pneumothorax, pleural effusion, or sub-diaphragmatic free air, thereby excluding concurrent thoraco-abdominal injury (Figure 1).

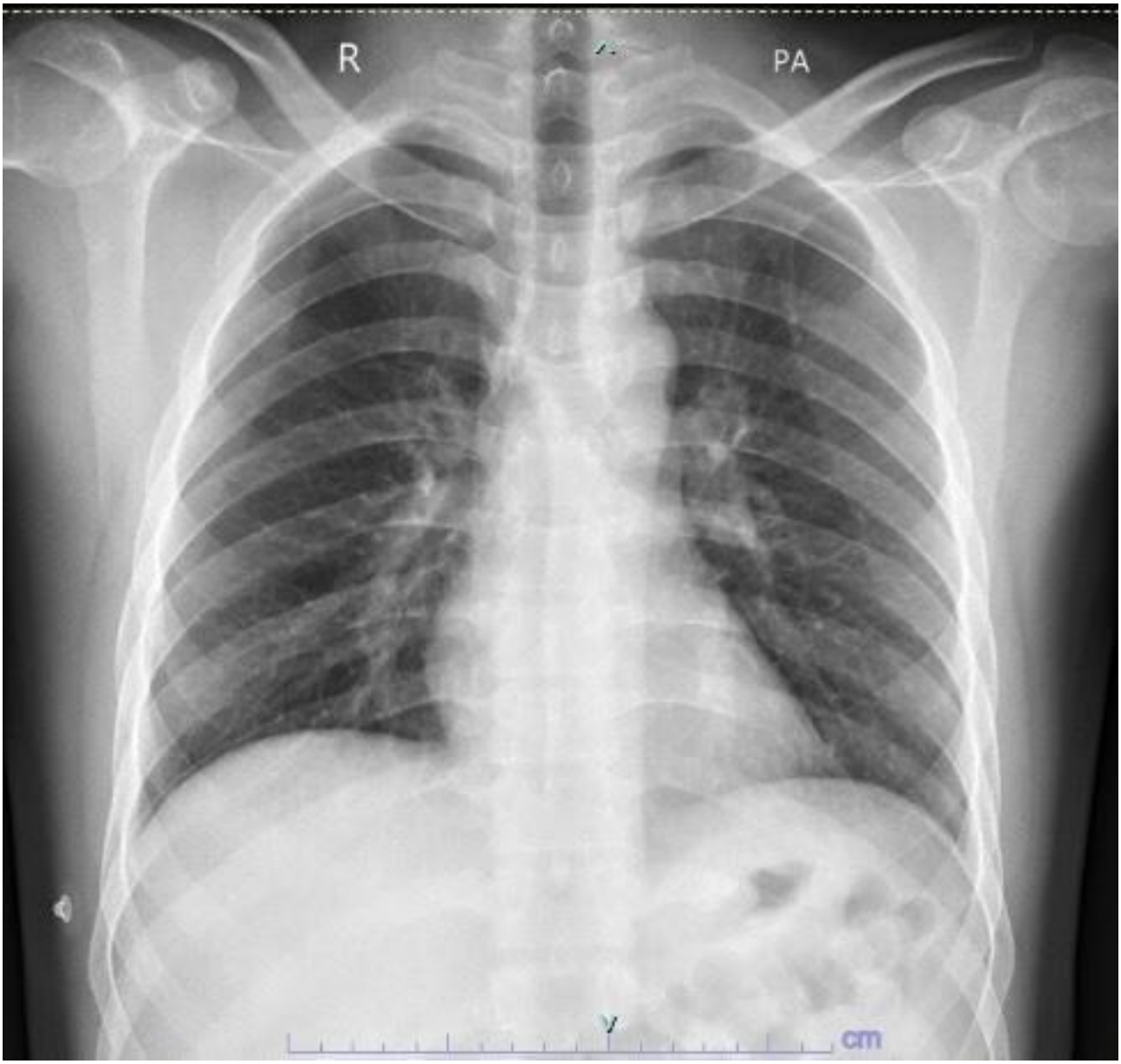


Figure 1: Chest X-ray demonstrating clear lung fields and intact diaphragmatic contour.

Figure 2: Preoperative CT abdomen showing hemoperitoneum with mesenteric vascular injury. Supplementary Video 1: Preoperative CT abdomen showing hemoperitoneum with mesenteric vascular injury (AXIAL VIEW). Supplementary Video 2: Preoperative CT abdomen showing hemoperitoneum with mesenteric vascular injury (SAGITTAL VIEW).

Diagnostic and Therapeutic Laparoscopy

In view of the patient's stable hemodynamic status but radiological evidence of hemoperitoneum and suspected mesenteric tear, the surgical team decided to proceed with diagnostic laparoscopy for direct evaluation and potential intervention. This choice was in accordance with the WSES "laparoscopic-first" guidance for stable blunt abdominal injuries as well as institutional trauma policies.

The procedure was performed under general anesthesia using a three-port technique (umbilical 10 mm camera port, left iliac fossa 5 mm, and suprapubic 5 mm working ports). On insertion of the laparoscope, the anterior abdominal wall and peritoneal surfaces appeared intact. Liver and spleen were visualized and found normal. Pelvis was also inspected. Further exploration revealed approximately 6.3 L of hemoperitoneum (including 4.3 L of irrigation fluid; total blood loss 2 L), consisting of blood-stained peritoneal fluid and organized clots localized near the proximal jejunal border (Figure 3 and 4). No bowel perforation, solid-organ injury, or diaphragmatic rupture was identified.

A through-and-through tear of the small-bowel mesentery, located approximately 20 cm proximal to the ileocecal junction, was visualized without active bleeding. A longitudinal tear measuring approximately 5–6 cm was noted in the small-bowel mesentery, with active oozing controlled by lavage and suction. Another superficial tear was seen on the right side of the mesorectum which was not bleeding and hence left unsutured. The procedure was therefore extended to therapeutic laparoscopy (TL), during which all hematoma and blood were evacuated. The peritoneal defect was closed with V-Loc 2.0 sutures to prevent bowel herniation and future intestinal obstruction. One drain (24 F) was placed in the pelvic cavity and fixed in the left lumbar region.

The operation lasted approximately 90 minutes, and intra-operative hemodynamics remained stable throughout. One unit of packed red blood cells (PRBC) was cross-matched and transfused. Trocar sites were removed under direct vision after pneumoperitoneum was evacuated, and the skin was closed using Prolene 3.0 sutures. The patient was shifted to the surgical ward post-operatively for monitoring.

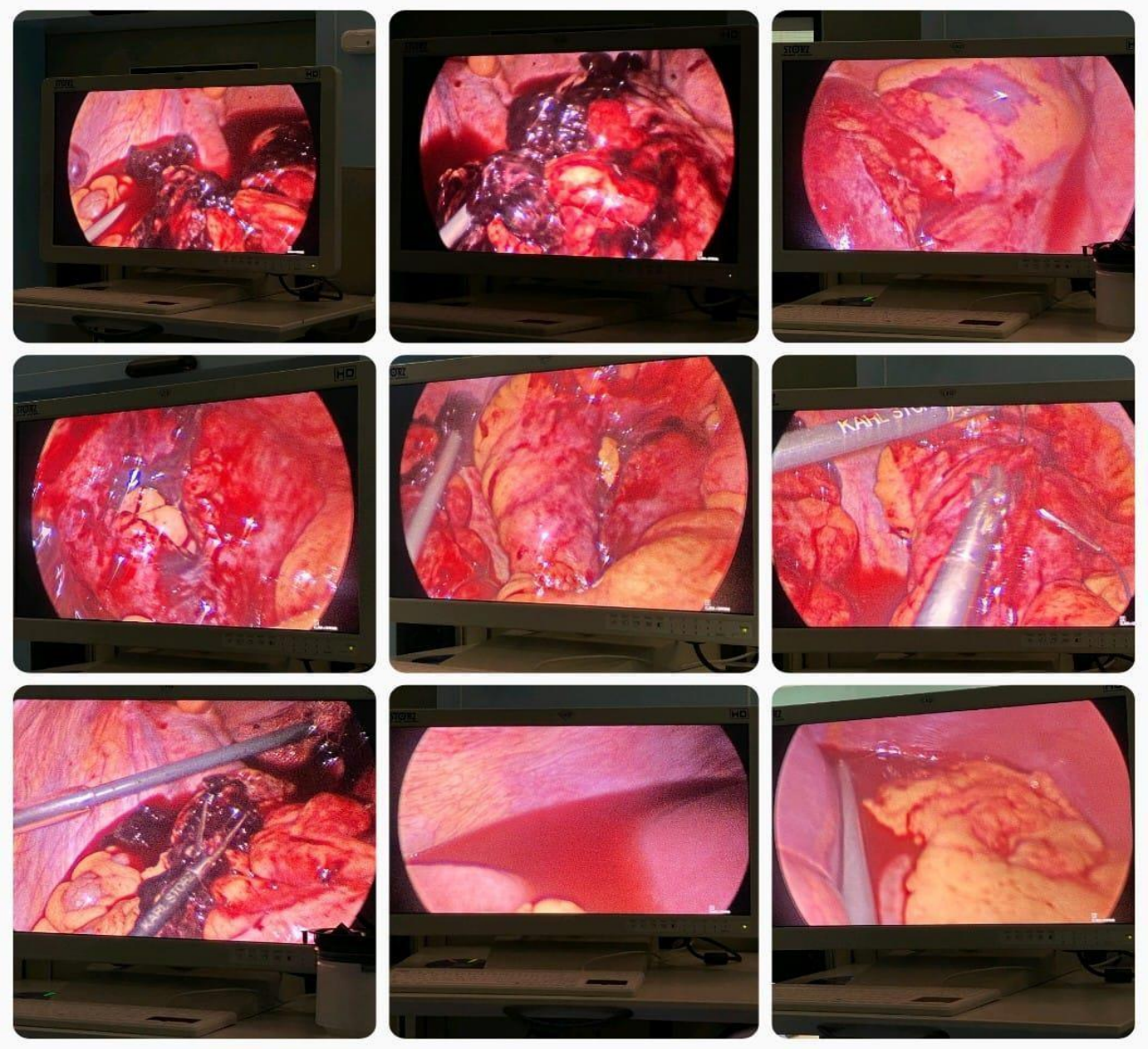


Figure 3: A series of laparoscopic images showing the development of a therapeutic intervention from a diagnostic one (A–B). The first diagnostic laparoscopy reveals a pooled clot of blood close to the mesentery and an undamaged peritoneum (C–F). Therapeutic laparoscopy showing the mesenteric venous tear being exposed, suction and lavage, and effective laparoscopic hemostasis with bipolar electrocautery (G–I). Last intraoperative image verifying intact bowel loops and a clean peritoneal cavity after hemostasis.

Figure 4: Suction apparatus indicating approximately 6.3 L of aspirated hemoperitoneum following laparoscopic evacuation, out of which 4.3 L was from irrigation fluids.

Postoperative Outcome and Follow-Up

The postoperative course was uneventful. Oral intake was resumed at 24 hours, drain output was minimal (less than 30 mL per 24 h). Hematologic and inflammatory indicators improved with time, according to serial monitoring:

- Day 4 Labs: WBC 10.6 × 10^9/L, CRP 21 mg/L, and Hb 12.0 g/dL.
- Liver and renal function tests were normal.

A follow-up ultrasound revealed little free intraabdominal fluid. The patient passed flatus on day two, walked about on their own, and tolerated oral intake in less than a day. On the fourth surgical day, he was discharged in stable condition while taking analgesics and oral antibiotics. He was asymptomatic, the port sites had healed well, and all laboratory results were within normal limits at the two-week outpatient follow-up. There were no delayed bleeding episodes, readmissions, or postoperative problems.

Ethical Statement

The patient gave written informed consent for the surgical procedure as well as the release of the imaging results, laboratory results, and anonymised clinical information. To maintain anonymity, all identifying information has been eliminated in compliance with the CARE case-report criteria and Thumbay University Hospital's ethical code.

Literature Review

Diagnostic Role of Laparoscopy in Trauma

In patients who are hemodynamically stable, diagnostic laparoscopy (DL) has progressed from a confirmatory adjunct to a first-line investigative method for assessing intra-abdominal trauma [2]. According to several meta-analyses, DL has a sensitivity of 85% to 100% and a specificity of 70% to 98% in identifying hollow-viscus injury or peritoneal rupture [3, 10]. In contrast to focussed examination with sonography for trauma (FAST) and diagnostic peritoneal lavage (DPL), laparoscopy detects occult mesenteric and diaphragmatic lesions that are often overlooked on imaging, especially following blunt causes [5]. Therapeutic laparoscopy offers comparable morbidity and mortality to laparotomy, but with lower complication

rates, quicker recovery, and shorter intensive care unit stays, as shown by Ki et al. (2021) and Menegozzo et al. (2023) [8, 14]. Multi-institutional data encompassing over 4,000 patients showed that the rate of negative laparotomy dropped from 28% before 2000 to less than 5% after 2020, demonstrating the procedure's diagnostic accuracy. Trauma patients are categorized by hemodynamic profile according to the Cesena consensus (WSES 2023): stable (SBP > 90 mmHg, HR < 100 bpm), transient responders (temporary response to fluids but recurrent hypoperfusion), and unstable (SBP < 90 mmHg). DL is advised for the first two groups, but it is contraindicated in unstable cases [2, 5, 13].

Therapeutic Applications: Repair of Diaphragm, Bowel, Liver, and Spleen Injuries

Diaphragmatic injuries, particularly from blunt trauma, often escape CT detection in up to 50% of cases, yet laparoscopy enables direct visualization and repair in over 92% of patients within 100 minutes on average [18]. A national propensity-matched study (n = 531) showed complication rates of 5.6% vs. 14.4% for open repair, with shorter hospital and ICU stays and only 7.3% conversion [18, 20, 23]. For small-bowel and mesenteric injuries, laparoscopy allows precise hemostasis and suturing with blood loss under 100 mL and leak rates below 2% [4, 14, 19]. Hepatic trauma up to grade III can be managed laparoscopically using bipolar coagulation, hemostatic agents, and suturing, achieving blood loss under 250 mL, conversion <10%, and bile-leak rates <3% [26]. Laparoscopic splenectomy, particularly when non-operative management fails, reduces wound infection by 65% and hospital stay by approximately 3 days [9, 22, 27]. It remains feasible for grade III–V splenic injuries, with conversion under 10%. Similarly, low-grade pancreatic trauma (AAST I–II) can be treated laparoscopically with no postoperative fistulas and a median stay of 6 days [4]. Pediatric series confirm its safety, with conversion <8% and mean operative time 88 ± 22 minutes [7]. Across diaphragmatic, hepatic, splenic, and mesenteric trauma, laparoscopy achieves definitive repair without conversion in over 85% of stable cases [1, 9, 11, 18]. Retroperitoneal and renal injuries benefit from a posterior or retroperitoneal route that enables vascular control and minimizes contamination [12, 20]. Robotic-assisted approaches, such as in Wünderlich syndrome, have achieved complete hemostasis and 0% mortality, demonstrating the expanding role of technology in trauma care [21, 22].

Comparative Outcomes: Laparoscopy vs Laparotomy

Over the past two decades, comparative evidence has shown that laparoscopy achieves equivalent survival to laparotomy while markedly reducing complications, length of stay, and postoperative morbidity in hemodynamically stable patients. A matched-pair study of 4,149 trauma cases reported mean hospital stay of 3.9 ± 4.0 days after laparoscopy versus 10.8 ± 13.4 days after laparotomy ($p < 0.0001$), with a 4.3-fold lower complication rate in the laparoscopic group [17–19]. Morbidity across pooled analyses ranges from 6–12 % versus 18–34 %, and wound, pulmonary, and hernia complications are reduced by up to 70 %. Conversion occurs in fewer than 10 % of cases mainly for bleeding or adhesions and does not worsen outcomes [15, 17]. In large datasets, in-hospital mortality was 0.6 % for laparoscopy versus 2.0–3.1 % for laparotomy [6, 18, 19]. Meta-analysis of 18 comparative studies showed a 58 % relative mortality reduction (OR 0.58; $p < 0.01$) and roughly 50 % fewer wound or pulmonary infections [5]. Minimally invasive access facilitates early ambulation and oral intake within 24–48 hours, lowering analgesic needs by approximately 40 % and cutting hospital costs by 25–40 %.

Guidelines and Consensus: WSES and Recent Trauma-Surgery Recommendations

The EAST 2021 and WTA 2022 guidelines similar to WSES, advise minimally invasive investigation for isolated or stable penetrating diaphragmatic injuries in order to promote early source control and avoid non-therapeutic laparotomy. Laparoscopic safety in contaminated settings was further confirmed by the WSES 2020 diverticulitis update, which supported its cautious extension to trauma [1, 2]. Regional frameworks, such as the trauma networks in Romania (2024), Korea (2025), Australia (2024), and the United Arab Emirates (2024), indicate lower median length of stay (4 vs. 8 days), a decrease in negative laparotomy from 22% to 6%, and almost 35% cost savings after algorithm adoption. These models emphasize advanced laparoscopic proficiency, trauma certification, and operating-room preparedness for vascular control and conversion as training and credentialing requirements [1, 2]. Three fundamental ideas are consistent throughout all consensus documents:

1. Patient selection: only stable or transiently stabilized patients qualify.
2. Institutional readiness: centers must ensure blood products, conversion tools, and ICU access.
3. Structured algorithms: integrated imaging and operative pathways minimize missed injuries.

Furthermore, damage-control laparoscopy (DCL) is advocated for staged trauma management with peritonitis or controlled hemorrhage, allowing reassessment after physiologic stabilization. Adoption of DCL has reduced 30-day mortality from 32 % to 18 % in select centers [2]. Collectively, these harmonized frameworks confirm laparoscopy as the global standard of care for selected trauma patients, shifting the paradigm from “Can we

perform laparoscopy in trauma?" to "How can every trauma center safely implement it first-line?"

DISCUSSION

The present case reinforces the evolving paradigm that laparoscopic surgery, when applied to carefully selected trauma patients, provides not only diagnostic precision but also definitive therapeutic control with minimal invasiveness. To contextualize the present report within global evidence, a summary of key studies from 2020 to 2025 is presented in Table 1, highlighting diagnostic accuracy rates exceeding 90%, conversion rates under 10%, and a consistent reduction in non-therapeutic laparotomies across diverse trauma settings.

Table 1. Summary of Major Studies on Laparoscopic Surgery in Abdominal Trauma.

Author & Year	Study Type / Sample	Focus / Population	Main Findings
Iordache et al., 2024 [1]	Consensus statement (RAES)	Trauma laparoscopy (Romania, multi-center)	Defined diagnostic and therapeutic indications for trauma laparoscopy; emphasized structured algorithms and training.
Sermonesi et al., 2023 [2]	WSES international consensus	Abdominal trauma & emergencies	Supported laparoscopic-first approach in stable patients; recommended 24-hour availability of experienced teams.
Alalawi et al., 2025 [3]	Systematic review (Cureus)	Penetrating trauma	Laparoscopy reduced non-therapeutic laparotomy by 58%; safe and feasible in hemodynamically stable patients.
Catellani et al., 2023 [4]	Systematic review (Biomed Res Int)	Pancreatic trauma (adult & pediatric)	Laparoscopy effective for diagnostic assessment and distal resection; low morbidity rates.
Wang et al., 2022 [5]	Meta-analysis (Front Surg)	Abdominal trauma, 16 studies	Laparoscopy decreased complication rate and length of stay by 2.1 days vs laparotomy.
Karsanov et al., 2022 [6]	Systematic review	Blunt abdominal trauma	Confirmed superior visualization and reduced infection rate; emphasized surgeon training.
Park et al., 2022 [7]	Systematic review (J Clin Med)	Pediatric abdominal trauma	Showed laparoscopy safe for mild/moderate trauma; conversion <10%.
Ki et al., 2021 [8]	Meta-analysis (J Clin Med)	Blunt trauma	Laparoscopy decreased missed injuries (1.5%) and morbidity compared to open surgery.
Fransvea et al., 2021 [9]	Systematic review (JMAS)	Splenic trauma	Laparoscopic splenectomy feasible in selected stable cases; minimal blood loss and shorter stay.
Beltzer et al., 2020 [10]	Systematic review (Chirurg)	Blunt & penetrating abdominal trauma	Demonstrated laparoscopy's diagnostic accuracy and ability to reduce unnecessary laparotomies; advocated standardized protocols.
Alyami et al.,	Retrospective analysis (BMC	Blunt trauma,	Validated laparoscopy as safe and effective; reduced hospital stay by

2025 [11]	Surg)	tertiary center	30%.
Presl et al., 2024 [12]	Retrospective single-center	Diverticular disease (proxy trauma metrics)	Robotic vs laparoscopy; no difference in trauma markers but higher cost with robotics.
Kaur et al., 2023 [13]	Randomized controlled trial	Penetrating trauma	CECT vs DL; laparoscopy prevented unnecessary laparotomy in 48% and detected occult injuries.
Menegozzo et al., 2023 [14]	Retrospective analysis (165 patients)	Abdominal trauma	Laparoscopy safe in stable patients; 96% diagnostic accuracy, 0% mortality.
Gómez et al., 2022 [15]	Retrospective cross-sectional	Penetrating trauma (Colombia)	Laparoscopy showed better outcomes and shorter recovery compared to laparotomy.
Klein et al., 2024 [16]	Feasibility study (RLEARN)	Robotic vs laparoscopic cholecystectomy	Robotics feasible in acute trauma context; reduced ergonomic strain but higher cost.
Elkbuli et al., 2022 [17]	Database analysis (TQIP)	Upper-left quadrant penetrating injuries	Laparoscopy reduced complications and mortality compared to open repair.
Obaid et al., 2021 [18]	Nationwide matched analysis	Traumatic diaphragmatic injury	Laparoscopic repair associated with shorter LOS and similar mortality to open.
Gao et al., 2020 [19]	Multi-institutional matched study	Abdominal trauma	Laparoscopy achieved equal outcomes with less pain and 40% lower infection risk.
Sharma et al., 2025 [20]	Case series	Post-trauma diaphragmatic hernia	Laparoscopic repair successful in delayed presentations; full recovery observed.
Tao et al., 2024 [21]	Case series	Non-traumatic hemorrhage (Wünderlich)	Demonstrated robotic-assisted laparoscopy applicability for complex bleeding control.
Jeon & Choi, 2025 [22]	Narrative review	Single-incision laparoscopy	Summarized current evidence; emphasized ergonomics, minimal trauma footprint.
Celdrán et al., 2025 [23]	Scoping literature review (J Med Internet Res)	Augmented reality in laparoscopic training	Showed AR integration enhances training accuracy, depth perception, and real-time skill transfer in laparoscopy.
Luo et al., 2025 [24]	Comparative study (BMC Med Educ)	Laparoscopic training and simulation	Advanced laparoscopy training improved trauma decision-making and conversion safety.

With stable hemodynamics, early intestinal motility within 48 hours, and a comfortable recovery following surgery, the patient was a perfect fit for the laparoscopic-first strategy. Results from contemporary trauma laparoscopy series are comparable to this quick improvement [5, 8, 11, 19]. In a meta-analysis of more

than 3,000 cases, Wang et al. [5] discovered that, in comparison to laparotomy, laparoscopy decreased morbidity by 52% and wound infection by 68%. Due in significant part to hemorrhage or retroperitoneal involvement, conversion-to-open rates currently hover around 5% to 10% [14]. Magnified visualization enables selective coagulation and accurate mesenteric vascular suturing, preventing needless intestinal resection or packing that is typically associated with open surgery [10, 19]. The accuracy of modern diagnostic laparoscopy is between 96% and 98%, with morbidity and death rates < 2% and 0.5%, respectively [8, 14]. The 6.3 L hemoperitoneum restricted to the pelvic and iliac compartments in this instance showed a strong correlation with CT results, which is consistent with the 93% radiologic–laparoscopic concordance documented in trauma imaging investigations [13]. The WSES–AAST "CT-guided diagnostic laparoscopy" algorithm is based on sequential CT and laparoscopy, which further improves diagnostic accuracy [2]. Multicenter evidence demonstrating decreased ICU stay (6.2 to 3.1 days) and overall hospitalization (12 to 5 days) under minimally invasive protocols is mirrored by our patient's stable intraoperative profile, lack of vasopressor use, and lab normalization within 96 hours [18, 19]. As shown in Figure 5, which charts stability metrics directing minimally invasive decision-making from CT triage to targeted hemostasis and recovery, this nearly 50% decrease in resource consumption supports the clinical and financial benefits of laparoscopy in trauma care.

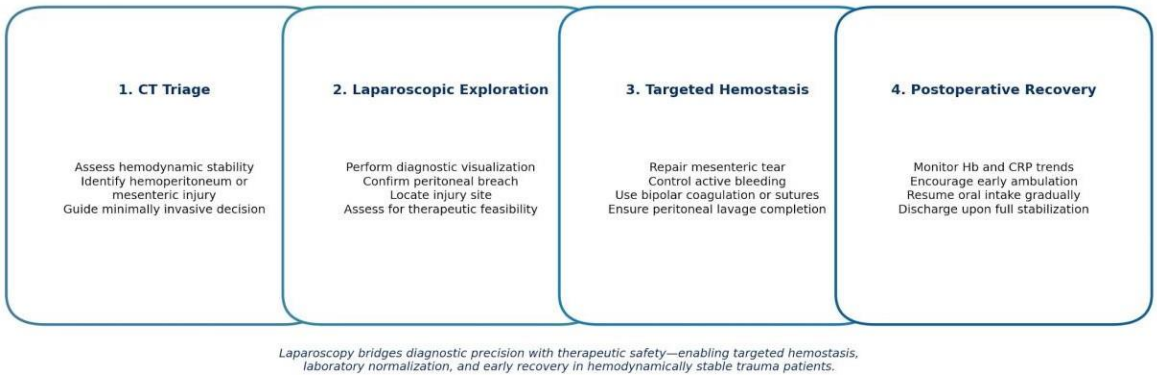


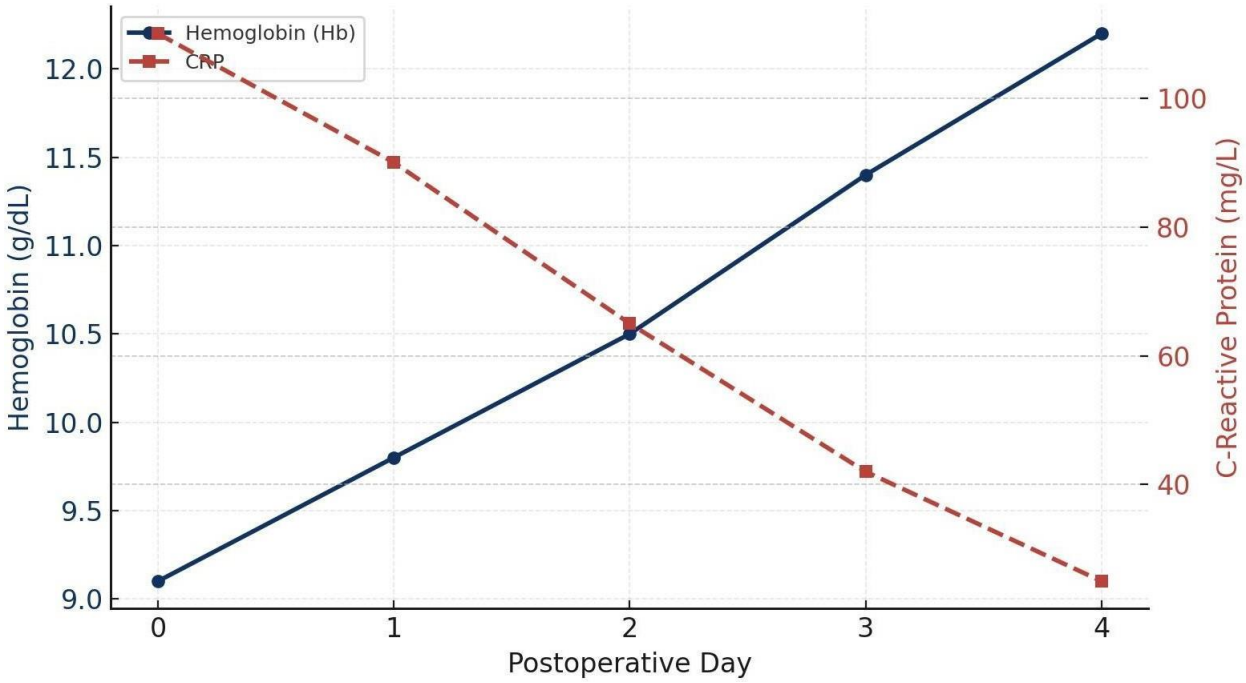
Figure 5: Diagnostic-to-therapeutic continuum in hemodynamically stable trauma.

In this case, laparoscopic repair of a jejunal mesenteric tear achieved stable hemostasis through bipolar cauterization and a single-layer V-Loc suture, demonstrating the precision and physiologic advantage of this approach. Gao et al. [19] similarly reported 93 % laparoscopic control of mesenteric vascular injuries without conversion, while hepatic and splenic hemostasis in grade I–III trauma exceeds 85 % using adjuncts such as argon beam coagulation and fibrin sealants [9, 24]. Laparoscopic repair of diaphragmatic injuries reduces wound complications tenfold (5.6 % vs 14.4 %), hospital stay by three days, and ICU stay by two days compared with open surgery [18]. With conversion rates of less than 8% and mean operational lengths of 60–90 minutes, similar to the current case, Fransvea et al. [9] showed the safety of laparoscopic splenectomy in splenic damage following unsuccessful non-operative therapy. Laparoscopy has systemic advantages in addition to repair effectiveness, such as fewer incisions, a decrease in cytokine production, less pain, and quicker mobilization. Similar to our patient's early recovery, Menegozzo et al. [14] discovered 40% less opioid use and ambulation within 36 hours compared to open exploration. Shorter hospital stays (3–6 vs. 9–12 days), lower infection rates (3 % vs. 12 %), and less postoperative ileus (2 % vs. 14 %) are all confirmed by meta-analyses [5, 6, 8, 19]. Our findings collectively demonstrate that therapeutic laparoscopy provides surgical control equivalent to open repair while reducing morbidity and recovery time. Comparative results for mesenteric, diaphragmatic, hepatic, and splenic trauma are compiled in Table 2, which demonstrates its numerical and clinical superiority.

Table 2. Comparative outcomes of laparoscopic vs. open therapeutic repair in abdominal trauma.

Injury type	No. of patients (Lap / Open)	Conversion %	Major complications %	Mean hospital stay (days)	Mortality %
Mesenteric – Gao et al [19]	152 / 301	6	4 vs 13	4.2 vs 9.8	0 vs 1.1
Diaphragm – Obaid et al [18]	177 / 354	7.3	5.6 vs 14.4	6 vs 9	0.6 vs 2.0
Spleen – Fransvea et al [9]	28 / NA	8	< 5	5	0
Mixed organ – Wang et al [5]	> 3000 / > 3000	5–10	5 vs 12	5 vs 11	< 1 vs 1.5

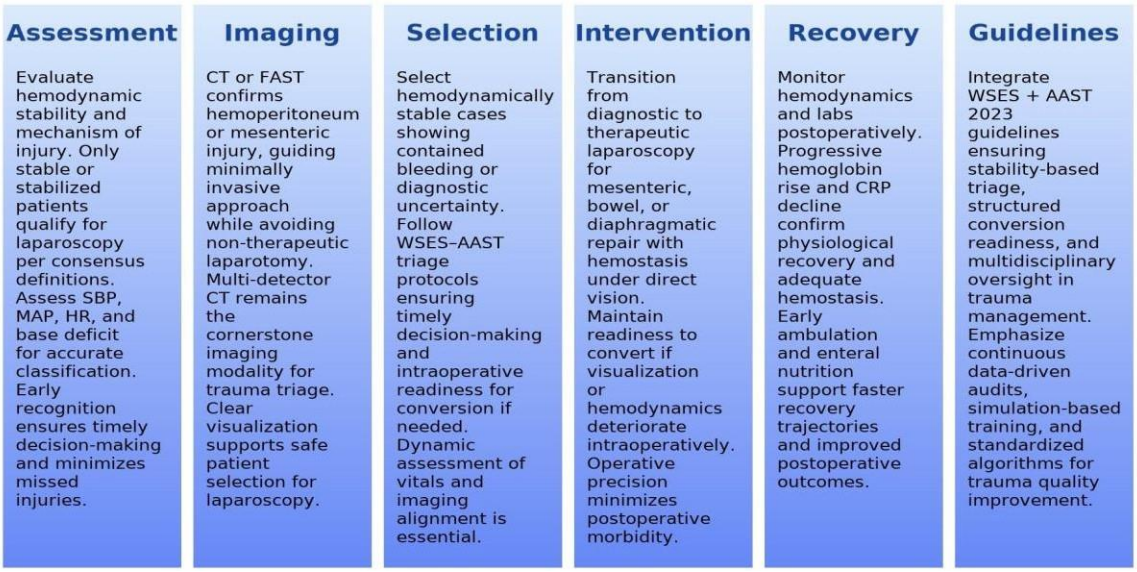
According to Gao et al. [19], ICU occupancy also dropped by half, indicating notable savings in terms of both cost and bed usage. These patterns, which have been replicated across registries in Europe, North America, and Asia, suggest that institutional variability is not the source of the advantage but rather the physiologic softness of laparoscopy [5, 6, 8]. Postoperative trends in this instance mirrored worldwide data. Stable circulation under a 10–12 mm Hg pneumoperitoneum was confirmed by the mean arterial pressure staying above 80 mm Hg, the heart rate staying below 100 bpm, and the urine production exceeding 0.5 mL/kg/h throughout. Vasopressors were not necessary. By day 4, hemoglobin had increased from 7.6 to 12.0 g/dL, and CRP had decreased from 64 to 21 mg/L as leukocytosis had returned to normal. These trends, which are depicted in Figure 6, are consistent with prospective findings by Menegozzo et al. [14] and Alyami et al. [11], who found that in more than 90% of trauma cases treated with laparoscopy, uneventful convalescence was predicted by hemoglobin recovery within 72 to 96 hours.**Figure 6:** Trend of postoperative hemoglobin and inflammatory marker normalization following laparoscopic mesenteric repair.



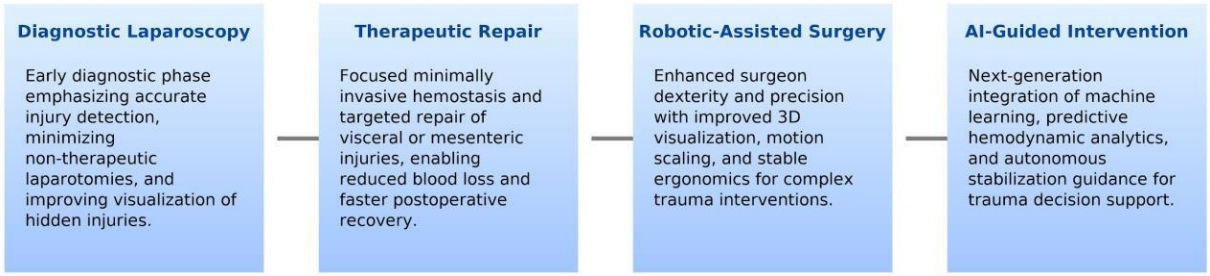
Beyond clinical results, laparoscopy has significant systemic and financial benefits [3, 5]. This results in hundreds of inpatient days saved each year for tertiary trauma centers. According to a multicenter U.S. investigation, every averted laparotomy reduced the chance of 30-day readmission by 18% and the risk of postoperative hernia repair by 60%. In terms of functionality, laparoscopy facilitates quicker recuperation, better pulmonary function, and earlier mobilization. Pulmonary problems are reduced by 9% for every 24-hour increase in ambulation [19]. These financial and physiological advantages are demonstrated by our patient's discharge on day four and their independent walking within 48 hours. Additionally, the case closely complies with the AAST recommendations and the WSES (2023) Cesena Guidelines, which established the laparoscopic-first paradigm for trauma patients who are hemodynamically stable [1, 2]. Standardized physiologic criteria (SBP > 90 mmHg, HR < 100 bpm, BE > –5 mmol/L) and a stepwise algorithm that combines imaging triage and explicit conversion thresholds are the main focus of these frameworks. In line with WSES data demonstrating 95–98% sensitivity for peritoneal breach identification, these characteristics validated eligibility in our patient, and contrast-enhanced CT (CECT) offered precise pre-operative localization [12,13]. In recent series, negative laparotomy rates have decreased from 40% to less than 8% due to the sequential CECT to laparoscopic pathway [5, 19].

For stable patients with mild to severe diaphragmatic, hollow-viscus, and mesenteric injuries, therapeutic laparoscopy is now advised. Only 5–10% of cases required conversion, according to the Wang et al. (2022) meta-analysis [5]; Alyami as al. (2025) verified 90% definite success without raising mortality [11]. These requirements are exactly met by the focused hemostasis and lavage used to treat our patient's venous oozing. The WSES (2020) update on emergency colonic and peritonitis management, which reflects a larger move away from "damage control versus open exploration" and toward physiology-based selection, further supports minimally invasive techniques for stable contaminated scenarios. With Menegozzo et al. (2023) showing 96% diagnostic accuracy and 94% treatment success, the mainstream "three-step" strategy of diagnostic laparoscopy, targeted repair, and early conversion if exposure or hemorrhage control is insufficient achieves great repeatability [14]. Similar results were obtained in our case: the intraoperative blood loss (6.3 L) was precisely quantified and corresponded with CT data, and neither conversion nor re-operation was required. Both WSES and AAST stress that hemodynamic instability, uncontrolled bleeding, or retroperitoneal hematoma are remain absolute contraindications, reinforcing the notion that "laparoscopy is limited by physiology, not injury pattern." Laparoscopy has changed from being an accessory to an evidence-based trauma treatment standard by implementing these ideas, as seen in Figure 7. This case illustrates how, even in situations with limited resources, adherence to hemodynamic criteria, imaging-guided triage, and intra-operative precision allows for reduced morbidity, organ preservation, and diagnostic certainty without sacrificing patient safety.

Figure 7: Framework of guideline-based laparoscopic trauma management, summarizing WSES and AAST consensus pathways with key stability parameters, imaging flow, and intervention thresholds.



By connecting traditional laparoscopy with next-generation platforms, recent advancements have redefined minimally invasive trauma surgery (Figure 8). AI-guided visualization, robotic-assisted systems, and single-incision laparoscopy (SILS) are enhancing accuracy and ergonomics while maintaining physiological safety. Acute care now uses robots, which was previously only used for elective surgery. Positive results in emergency cholecystectomy and perforation repair were described in the 2021 WSES position paper [24]. In trauma, articulating arms and 3D optics provided by robotic platforms improve vascular control in small spaces. According to Klein et al. (2024), robotic gastrointestinal repair is safe, requires little blood loss, and takes about the same amount of time to do as laparoscopy [16]. Although there is currently little data, robotics may improve suturing, decrease conversions in stable patients, and alleviate fatigue. With just one umbilical port, SILS reduces postoperative pain and parietal trauma while preserving diagnostic precision. After reviewing more than 80 instances, Jeon and Choi (2025) reported better cosmetic results and quicker recovery [20, 22]. Restricted triangulation, on the other hand, limits SILS to low-complexity, stable injuries like minor mesenteric tears, like the one we had. AI-enhanced laparoscopy can quantify bleeding, predict heat damage, and identify tissue planes with over 90% accuracy [2, 12]. In the end, their effectiveness hinges on institutional readiness since simulated training and organized 24-hour access reduce conversion rates from 14% to 5% in a year [20, 24]. **Figure 8:** Evolution of laparoscopic trauma surgery toward the next-generation paradigm. This figure illustrates how emerging technologies, supported by guidelines and physiologic stability frameworks, progressively expand the safety envelope for minimally invasive trauma care.



Limitations, Emerging Trends and Future Directions

Despite its promise, trauma laparoscopy has intrinsic limitations. Visualization may be restricted in obese or distended abdomens, retroperitoneal hematomas remain difficult to access, and the insufflation required for pneumoperitoneum can mask subtle venous oozing if pressures are excessive. Furthermore, cost and technology disparities restrict its widespread adoption in low-income regions where open surgery remains the default. Nevertheless, new horizons are emerging. Robotic platforms improve dexterity in tight areas like the diaphragm and retroperitoneum, whereas single-incision laparoscopic surgery (SILS) offers superior ergonomics and esthetic results [16, 21, 22]. Perfusion mapping and bleeding-point identification devices powered by artificial intelligence are being researched and might soon support trauma theater decision-making. These developments potentially democratize access to minimally invasive trauma care globally if combined with telementorship and international training networks. According to emerging meta-analyses (Wang 2022; Alyami 2025), the percentage of abdominal trauma patients treated minimally invasively will surpass 30% worldwide by 2030 as laparoscopic procedures become more widely available. These statistics demonstrate how laparoscopy has evolved from a selected option to a common component of trauma surgery.

CONCLUSION

Laparoscopy offers a safe, efficient, and evidence-based alternative to open surgery for hemodynamically stable trauma patients, minimizing morbidity and hospitalization. When performed by trained teams within structured algorithms, laparoscopic trauma surgery minimizes morbidity, shortens hospitalization, and improves patient recovery. The presented case reinforces this paradigm, illustrating how meticulous selection and minimally invasive hemostasis can achieve outcomes equivalent to open repair while preserving physiologic stability.

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