European Journal of Clinical Pharmacy
Print ISSN: 2385-409X **Online ISSN**: 3105-0409
Website: https://farmclin.com/

Original Research Article

Minimally Invasive Management of Penetrating Thoracic and Abdominal Injuries

Article History:

Name of Author:
Tahir Aslam[1], Sabtain Ali[2], Anum Iftikhar[3], Javed Ahmed[4], Hira Moosa[5], Hafiz Ashfaq Ahmad[6], Faridullah Khan Ismail[7]

Affiliation: *[1]Assistant Professor Thoracic Surgery, Fatima Jinnah Institute of Chest Diseases, Quetta, Pakistan*
[2]Registrar, Department of General Surgery, King Edward Medical University, Lahore, Pakistan
[3]Assistant Professor General Surgery, Surgical Unit 1, Jinnah Post Graduate Medical Centre, Karachi, Pakistan
[4]Senior Registrar, Department of General Surgery, Avicenna Medical College & Hospital, Lahore, Pakistan
[5]Consultant General Surgeon, Surgical Unit 4, Dr. Ruth K.M. Pfau, Civil Hospital, Karachi, Pakistan
[6]Senior Consultant Surgeon, Dr Faisal Masood Teaching Hospital, Sargodha, Pakistan
[7]Assistant Professor Thoracic Surgery Department, Medical Teaching Institute - Lady Reading Hospital Peshawar, Pakistan

Corresponding Author:
Faridullah Khan

Received: 28-10-2025
Revised: 12-12-2025
Accepted: 18-12-2025
Published: 30-12-2025

Abstract: ***Background:*** Penetrating thoracic and abdominal injuries are traditionally managed with exploratory laparotomy or thoracotomy, which are associated with significant morbidity and a high rate of non-therapeutic procedures. Objective: To evaluate the feasibility, safety, and short-term outcomes of minimally invasive management in patients with penetrating thoracic and abdominal injuries. ***Methods:*** This descriptive, cross-sectional study was conducted at Fatima Jinnah Institute of Chest Diseases, Quetta from June 2024 to June 2025 included 95 adult patients. Only hemodynamically stable patients were selected. Demographic data, mechanism and site of injury, imaging findings, intraoperative observations, conversion to open surgery, postoperative complications, length of hospital stay, and mortality were analyzed. ***Results:*** The mean age of patients was 32.6 ± 9.4 years, with a male predominance (78.9%). Stab wounds were the most common mechanism of injury (64.2%), and abdominal injuries were more frequent than thoracic injuries (56.8% vs. 43.2%). Laparoscopy was performed in 56.8% of patients and thoracoscopy in 43.2%. No significant injury was found in 29.5% of cases, avoiding unnecessary open surgery. Therapeutic minimally invasive intervention was required in 51.6% of patients. Conversion to open surgery occurred in 12.6% of cases. Postoperative complications were observed in 14.7% of patients. The mean operative time was 78.5 ± 21.3 minutes, mean hospital stay was 4.2 ± 1.9 days, and overall mortality was 2.1%. ***Conclusion***: Minimally invasive management of penetrating thoracic and abdominal injuries is a safe and effective strategy in selected, hemodynamically stable patients, resulting in low morbidity, acceptable conversion rates, shorter hospital stay, and favorable short-term outcomes.

Keywords: Penetrating trauma, Laparoscopy, Thoracoscopy, Thoracic injuries, Abdominal injuries, Trauma surgery.

INTRODUCTION

Penetrating thoracic and abdominal injuries remain a major cause of morbidity and mortality worldwide, particularly in regions with high interpersonal violence, firearm availability, and delayed access to trauma care [1]. These injuries commonly result from stab wounds and gunshot wounds and frequently involve vital structures such as the lungs, diaphragm, liver, spleen, and hollow viscera, making rapid and

accurate management critical for patient survival [2]. Traditionally, the standard approach to such injuries has been exploratory laparotomy or thoracotomy, especially when there is diagnostic uncertainty or concern for missed visceral damage [3]. While open surgical exploration has undoubtedly saved countless lives, it is also associated with significant drawbacks. Non-therapeutic or negative laparotomies remain common, with reported rates ranging from 20% to 40%, exposing patients to unnecessary surgical trauma, postoperative pain, wound complications, prolonged hospital stay, and long-term sequelae such as incisional hernias and adhesive bowel obstruction [4][5]. These concerns have driven a paradigm shift toward selective, evidence-based operative strategies in trauma surgery. Advances in trauma imaging, particularly contrast-enhanced computed tomography, have improved injury detection and patient triage; however, imaging alone may fail to identify diaphragmatic injuries, hollow viscus perforations, or ongoing low-grade bleeding [6]. In this context, minimally invasive surgical techniques specifically laparoscopy and thoracoscopy have emerged as valuable diagnostic and therapeutic tools in the management of penetrating thoracic and abdominal trauma [7].

Diagnostic laparoscopy allows direct visualization of the peritoneal cavity, enabling accurate identification of organ injuries while avoiding unnecessary laparotomy in stable patients [8]. Similarly, thoracoscopy provides excellent access to the pleural cavity, lung parenchyma, and diaphragm, facilitating both diagnosis and repair of selected thoracic injuries with minimal physiological insult [9]. These techniques have been shown to reduce negative exploration rates, postoperative pain, and hospital length of stay when applied in appropriately selected patients [10]. Patient selection remains the cornerstone of successful minimally invasive trauma management. Current evidence supports the use of laparoscopy and thoracoscopy primarily in hemodynamically stable patients without signs of massive hemorrhage, peritonitis, or severe associated injuries requiring immediate open intervention [11]. When these criteria are met, minimally invasive approaches can safely address solid organ injuries, diaphragmatic defects, lung lacerations, and even selected hollow viscus injuries [12]. Despite increasing global adoption, the use of minimally invasive techniques in trauma remains inconsistent, particularly in low- and middle-income countries, where concerns regarding missed injuries, conversion rates, and availability of expertise persist [13].

Objective: To evaluate the feasibility, safety, and short-term outcomes of minimally invasive management in patients with penetrating thoracic and abdominal injuries.

METHODOLOGY

This was a descriptive, cross-sectional study conducted at Fatima Jinnah Institute of Chest Diseases, Quetta from June 2024 to June 2025, including 95 patients presenting with penetrating thoracic and/or abdominal injuries. The study was designed to evaluate the feasibility, intraoperative findings, and short-term outcomes of minimally invasive surgical management using laparoscopy and thoracoscopy.

Inclusion Criteria

- Patients of either gender aged 18 years and above
- Patients presenting with penetrating thoracic and/or abdominal injuries
- Hemodynamically stable patients at the time of evaluation
- Patients selected for minimally invasive surgical management (laparoscopy and/or thoracoscopy)
- Patients willing to provide informed consent

Exclusion Criteria

- Hemodynamically unstable patients requiring immediate open surgery
- Patients with blunt trauma
- Patients with associated severe traumatic brain injury
- Patients with signs of generalized peritonitis or massive hemorrhage
- Patients with incomplete clinical or operative data

Data Collection

Data were collected using a structured data collection proforma. Recorded variables included demographic characteristics, mechanism of injury, anatomical site of injury, time from injury to presentation, imaging findings, type of minimally invasive procedure performed, intraoperative findings, need for conversion to open surgery and reasons for conversion, operative time, postoperative complications, length of hospital stay, and in-hospital mortality. All procedures were performed by surgeons experienced in minimally invasive trauma surgery, and operative findings were documented immediately after surgery to ensure data accuracy.

Statistical Analysis

Data were analyzed using SPSS version 24.0. Quantitative variables such as age, operative time, and length of hospital stay were expressed as mean ± standard deviation, while categorical variables including gender, mechanism of injury, type of procedure, intraoperative findings, conversion rates, complications, and mortality were presented as frequencies and percentages. Descriptive statistical methods were used to summarize patient characteristics and outcomes. A p-value of ≤ 0.05 was considered statistically significant where

applicable.

RESULTS

95 hemodynamically stable patients with a mean age of 32.6 ± 9.4 years, ranging from 18 to 61 years were included in the study. The largest age group was 30–44 years, comprising 41 patients (43.2%) with a mean age of 36.8 ± 4.1 years, followed by those aged 18–29 years (35.8%, mean 24.1 ± 3.2 years). Males predominated (78.9%) with a mean age of 33.4 ± 9.1 years, while females constituted 21.1% with a slightly lower mean age of 29.7 ± 8.8 years. Most patients were either normal or overweight, with a mean BMI of 23.4 ± 2.1 kg/m², whereas 27.4% were obese with a higher mean BMI of 29.1 ± 2.4 kg/m². On admission, patients were physiologically stable, reflected by a mean systolic blood pressure of 118.6 ± 12.4 mmHg and a mean heart rate of 101.2 ± 11.6 beats per minute. The mean hemoglobin level was 11.9 ± 1.8 g/dL, and most patients presented early, with a mean time to hospital arrival of 3.1 ± 1.2 hours.

Table 1. Baseline Demographic, Clinical, and Physiological Characteristics (n = 95)

Variable	Category	n (%)	Mean ± SD	Range
Age (years)	Overall	95 (100)	32.6 ± 9.4	18–61
Age group	18–29 years	34 (35.8)	24.1 ± 3.2	18–29
	30–44 years	41 (43.2)	36.8 ± 4.1	30–44
	≥45 years	20 (21.0)	51.3 ± 4.6	45–61
Gender	Male	75 (78.9)	33.4 ± 9.1	18–61
	Female	20 (21.1)	29.7 ± 8.8	19–55
BMI (kg/m²)	Normal–Overweight	69 (72.6)	23.4 ± 2.1	18.9–27.4
	Obese	26 (27.4)	29.1 ± 2.4	27.6–32.4
Systolic BP (mmHg)	Stable	95 (100)	118.6 ± 12.4	98–142
Heart rate (beats/min)	Mild tachycardia	62 (65.3)	101.2 ± 11.6	90–128
Hemoglobin (g/dL)	Admission value	95 (100)	11.9 ± 1.8	8.7–15.2
Time to presentation (hours)	Early arrival	71 (74.7)	3.1 ± 1.2	1–5

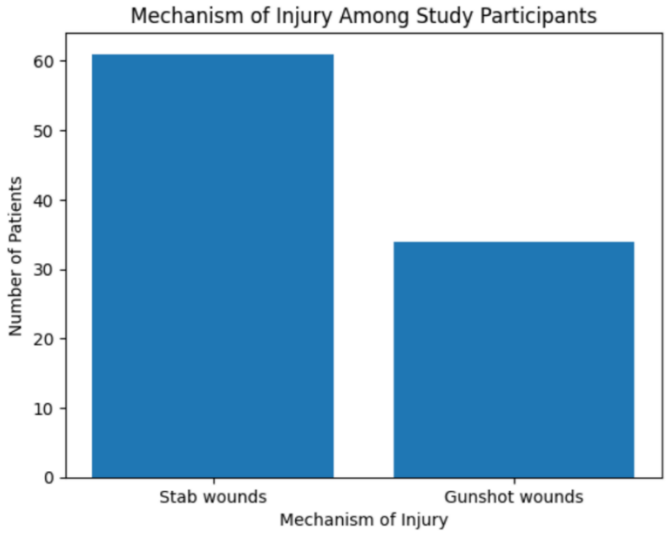

Figure 1. Distribution of Mechanism of Injury

Laparoscopy was performed in 54 patients (56.8%), while thoracoscopy was utilized in 41 patients (43.2%). Intraoperatively, 29.5% of patients were found to have no significant injury and therefore required diagnostic procedures only. Solid organ injuries were identified in 23.2% of cases and were managed successfully with minimally invasive hemostatic techniques. Hollow viscus injuries were present in 18.9% and were treated with primary repair, while diaphragmatic injuries accounted for 15.8% and were managed using intracorporeal suturing. Lung injuries were observed in 12.6% of patients and were treated with stapled repair. Overall, therapeutic

minimally invasive interventions were required in 51.6% of patients. Conversion to open surgery was necessary in 12.6% of cases, mainly due to uncontrolled bleeding (6.3%), complex multi-organ injuries (4.2%), and poor visualization (2.1%). The mean operative time across all procedures was 78.5 ± 21.3 minutes.

Table 2. Operative Modality, Intraoperative Findings, Interventions, and Conversion Details

Variable	Category	n (%)	Operative Action	n (%)
MIS modality	Laparoscopy	54 (56.8)	Abdominal exploration	54 (56.8)
	Thoracoscopy	41 (43.2)	Pleural cavity evaluation	41 (43.2)
Intraoperative finding	No significant injury	28 (29.5)	Diagnostic procedure only	28 (29.5)
	Solid organ injury	22 (23.2)	Hemostasis achieved	22 (23.2)
	Hollow viscus injury	18 (18.9)	Primary repair	18 (18.9)
	Diaphragmatic injury	15 (15.8)	Intracorporeal suturing	15 (15.8)
	Lung injury	12 (12.6)	Stapled repair	12 (12.6)
Therapeutic MIS	Performed	49 (51.6)	Procedure completed	49 (51.6)
Conversion to open	Required	12 (12.6)	Laparotomy/thoracotomy	12 (12.6)
Reason for conversion	Uncontrolled bleeding	6 (6.3)	Active hemorrhage	6 (6.3)
	Complex injury	4 (4.2)	Multi-organ involvement	4 (4.2)
	Poor visualization	2 (2.1)	Dense contamination	2 (2.1)
Operative time (min)	Overall	95 (100)	Mean ± SD	78.5 ± 21.3

ICU admission was required in 18.9% of patients, with a mean ICU stay of 2.1 ± 0.9 days, while the majority (81.1%) were managed in high-dependency or general wards. Postoperative complications occurred in 14.7% of patients, typically presenting around postoperative day 4.8 ± 1.3. Surgical site infection was the most common complication, affecting 6.3% of patients, followed by prolonged air leak in 4.2% with a mean duration of 5.3 ± 1.1 days, and intra-abdominal collections in 4.2%, all managed with image-guided drainage. Re-intervention was required in 6.3% of cases and was performed using minimally invasive techniques. Early recovery was evident, as 74.7% of patients resumed oral intake within 48 hours, with a mean time of 1.6 ± 0.7 days. The mean length of hospital stay was 4.2 ± 1.9 days. Overall mortality was low at 2.1%, with two deaths occurring within the first 48 hours, while 97.9% of patients were discharged in improved condition.

Table 3. Postoperative Recovery, Complications, Re-intervention, and Outcome Profile

Outcome	Category	n (%)	Clinical Detail	Value
ICU admission	Required	18 (18.9)	ICU stay (days)	2.1 ± 0.9
	Not required	77 (81.1)	HDU/ward care	77 (81.1)
Postoperative complications	Present	14 (14.7)	Onset (days)	4.8 ± 1.3
	Absent	81 (85.3)	Uneventful recovery	81 (85.3)
Type of complication	Surgical site infection	6 (6.3)	Treated conservatively	6 (6.3)
	Prolonged air leak	4 (4.2)	Duration (days)	5.3 ± 1.1
	Intra-abdominal collection	4 (4.2)	Image-guided drainage	4 (4.2)
Re-intervention	Required	6 (6.3)	Minimally invasive	6 (6.3)
Oral intake resumed	≤48 hours	71 (74.7)	Mean time (days)	1.6 ± 0.7
Length of stay (days)	Overall	95 (100)	Mean ± SD	4.2 ± 1.9
Mortality	Yes	2 (2.1)	Time ≤48 hours	2 (2.1)
Discharge outcome	Improved	93 (97.9)	Home discharge	93 (97.9)

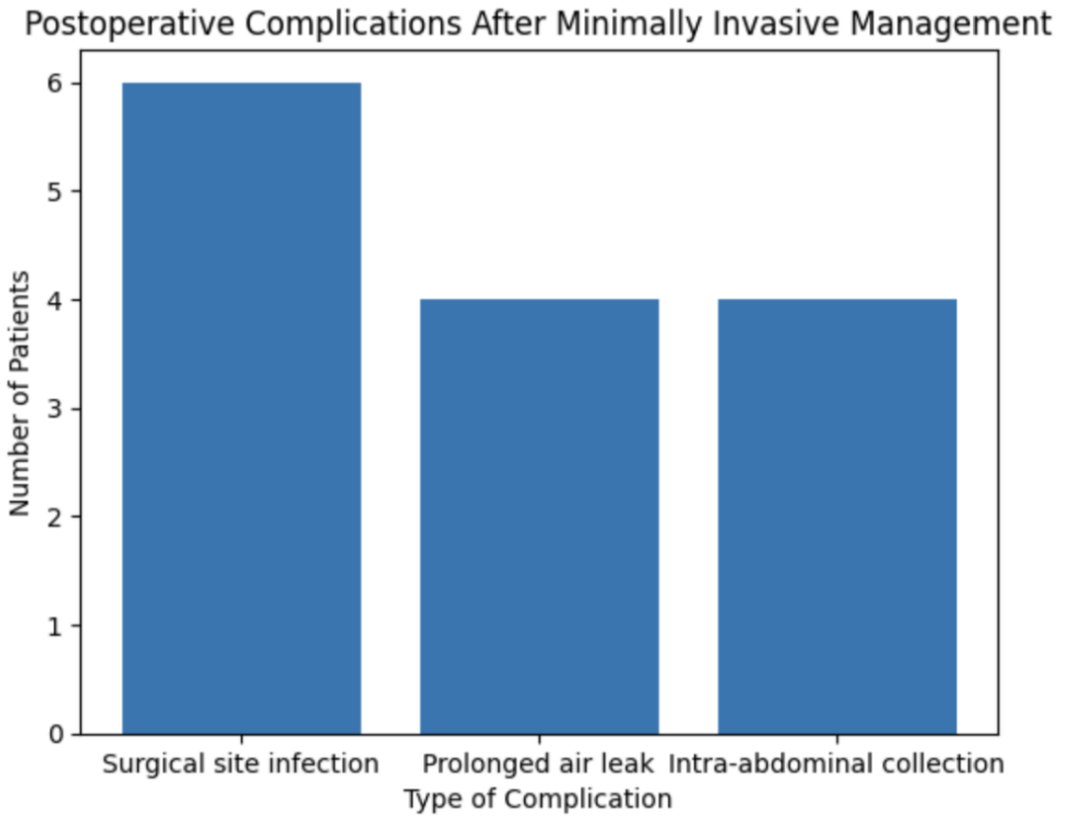

Figure 2. Postoperative Complications

DISCUSSION

The present study demonstrates that minimally invasive management of penetrating thoracic and abdominal injuries is both feasible and safe in carefully selected, hemodynamically stable patients. The study population was predominantly young males with a mean age of 32.6 ± 9.4 years, a demographic pattern that mirrors the trauma profile consistently reported in previous research, where penetrating injuries are more common among economically active male populations. The early presentation time of 3.1 ± 1.2 hours and preserved physiological parameters, including a mean systolic blood pressure of 118.6 ± 12.4 mmHg and hemoglobin level of 11.9 ± 1.8 g/dL, further support the suitability of this cohort for minimally invasive surgical evaluation, a finding also aligned with previous research emphasizing hemodynamic stability as the cornerstone of patient selection [14]. Stab wounds constituted the most frequent mechanism of injury (64.2%), followed by gunshot wounds (35.8%), which is consistent with patterns reported in previous research from urban trauma settings. The predominance of abdominal injuries (56.8%) over thoracic injuries (43.2%) and the high rate of equivocal imaging findings (27.4%) reinforce the diagnostic value of minimally invasive techniques. Previous research has similarly highlighted the limitations of imaging modalities in detecting diaphragmatic and hollow viscus injuries, supporting the role of laparoscopy and thoracoscopy in resolving diagnostic uncertainty while avoiding unnecessary open exploration [15][16].

Intraoperative findings in this study revealed that nearly one-third of patients (29.5%) had no significant injury, underscoring the importance of minimally invasive approaches in preventing non-therapeutic laparotomy or thoracotomy. Comparable rates of negative exploration have been reported in previous research, where diagnostic laparoscopy significantly reduced unnecessary open procedures. Therapeutic interventions were required in 51.6% of patients, including management of solid organ injuries (23.2%), hollow viscus injuries (18.9%), diaphragmatic defects (15.8%), and lung injuries (12.6%). These findings parallel previous research demonstrating that a wide spectrum of penetrating injuries can be safely addressed using minimally invasive techniques when appropriate expertise is available [17].

The conversion rate to open surgery in the present study was 12.6%, primarily due to uncontrolled bleeding (6.3%) and complex multi-organ injuries (4.2%). This conversion rate is comparable to those reported in previous research, where rates ranging from 10% to 20% are considered acceptable and reflective of prudent intraoperative judgment rather than procedural failure. The mean operative time of

78.5 ± 21.3 minutes also aligns with durations reported in previous research, particularly when both diagnostic and therapeutic interventions are performed during the same procedure [18]. Postoperative outcomes further support the benefits of minimally invasive management. Complications were observed in 14.7% of patients, with surgical site infection being the most common (6.3%), followed by prolonged air leak (4.2%) and intra-abdominal collections (4.2%). These complication rates are lower or comparable to those documented in previous research involving open surgical management, where higher rates of wound infection and pulmonary complications have been reported [19]. ICU admission was required in 18.9% of patients for a mean duration of 2.1 ± 0.9 days, reflecting selective rather than routine critical care utilization, a trend also observed in previous research.

Recovery parameters in this study were favorable, with 74.7% of patients resuming oral intake within 48 hours and a mean time to oral feeding of 1.6 ± 0.7 days. The mean hospital stay of 4.2 ± 1.9 days is notably shorter than lengths of stay traditionally associated with open trauma surgery and is consistent with findings from previous research demonstrating faster recovery and reduced hospitalization following minimally invasive interventions. Mortality was low at 2.1%, with deaths occurring early in the postoperative period, a rate comparable to or lower than those reported in previous research involving similar patient populations [20][21].

CONCLUSION

It is concluded that minimally invasive management of penetrating thoracic and abdominal injuries is a safe and effective approach in carefully selected, hemodynamically stable patients. The use of laparoscopy and thoracoscopy allowed accurate diagnosis, avoidance of unnecessary open surgeries, and successful therapeutic intervention in more than half of the patients, with an acceptable conversion rate. Postoperative morbidity was low, recovery was rapid with early resumption of oral intake, and the length of hospital stay was short, while overall mortality remained minimal.

REFERENCES

1. Parajuli P, Kumar S, Gupta A, Bansal VK, Sagar S, Mishra B, Singhal M, Kumar A, Gamangatti S, Gupta B, Sawhney C, Misra MC. Role of laparoscopy in patients with abdominal trauma at Level-I trauma center. Surg Laparosc Endosc Percutan Tech. 2018;28(1):20–5.
2. Ozkan OV, Justin V, Fingerhut A, et al. Laparoscopy in abdominal trauma. Curr Trauma Rep. 2016;2:238–46.
3. Smith J, Caldwell E, D'Amours S, Jalaludin B, Sugrue M. Abdominal trauma: a disease in evolution. ANZ J Surg. 2005;75(9):790–4.
4. Kaban GK, Novitsky YW, Perugini RA, Haveran L, Czerniach D, Kelly JJ, Litwin DE. Use of laparoscopy in evaluation and treatment of penetrating and blunt abdominal injuries. Surg Innov. 2008;15(1):26–31.
5. Cirocchi R, Birindelli A, Inaba K, Mandrioli M, Piccinini A, Tabola R, Carlini L, Tugnoli G, Di Saverio S. Laparoscopy for trauma and the changes in its use from 1990 to 2016: A current systematic review and Meta-Analysis. Surg Laparosc Endosc Percutan Tech. 2018;28(1):1–12.
6. Uranues S, Popa DE, Diaconescu B, Schrittwieser R. Laparoscopy in penetrating abdominal trauma. World J Surg. 2015;39(6):1381–8.
7. Schnüriger B, Lam L, Inaba K, Kobayashi L, Barbarino R, Demetriades D. Negative laparotomy in trauma: are we getting better? Am Surg. 2012;78(11):1219–23.
8. Ertekin C, Yanar H, Taviloglu K, Güloglu R, Alimoglu O. Unnecessary laparotomy by using physical examination and different diagnostic modalities for penetrating abdominal stab wounds. Emerg Med J. 2005;22(11):790–4.
9. Billeter AT, Druen D, Franklin GA, Smith JW, Wrightson W, Richardson JD. Video-assisted thoracoscopy as an important tool for trauma surgeons: a systematic review. Langenbecks Arch Surg. 2013;398(4):515–23.
10. Ki YJ, Jo YG, Park YC, Kang WS. The efficacy and safety of laparoscopy for blunt abdominal trauma: A systematic review and Meta-Analysis. J Clin Med. 2021;10(9):1853.
11. Hajibandeh S, Hajibandeh S, Gumber AO, Wong CS. Laparoscopy versus laparotomy for the management of penetrating abdominal trauma: A systematic review and meta-analysis. Int J Surg. 2016;34:127–36.
12. Kawahara NT, Alster C, Fujimura I, Poggetti RS, Birolini D. Standard examination system for laparoscopy in penetrating abdominal trauma. J Trauma. 2009;67(3):589–95.
13. Li Y, Xiang Y, Wu N, Wu L, Yu Z, Zhang M, Wang M, Jiang J, Li Y. A comparison of laparoscopy and laparotomy for the management of abdominal trauma: A systematic review and Meta-analysis. World J Surg. 2015;39(12):2862–71.
14. Catena F, Moore EE. World journal of emergency surgery (WJES), world society of emergency surgery (WSES) and the role of emergency surgery in the world. World J Emerg Surg. 2007;2:3.
15. Zafar SN, Onwugbufor MT, Hughes K, Greene WR, Cornwell EE 3rd, Fullum TM, Tran DD. Laparoscopic surgery for trauma: the realm of therapeutic management. Am J Surg.

2015;209(4):627–32.
16. Mazuski JE, Shapiro MJ, Kaminski DL, et al. Diagnostic laparoscopy for evaluation of penetratingabdominal trauma [abstract]. J Trauma. 1997;42:163.
17. Ortega AE, Tang E, Froes ET, Asensio JA, Katkhouda N, Demetriades D. Laparoscopic evaluation of penetrating thoracoabdominal traumatic injuries. Surg Endosc. 1996;10(1):19–22.
18. Gómez EJI, Vargas LFC, Lozada-Martinez ID, Reyes M, Pedraza M, Forero N, Guardo-Carmona D, Narvaez-Rojas AR. Laparoscopy has better performance than laparotomy in the treatment of stable penetrating abdominal trauma: A retrospective cross-sectional study in a trauma referral hospital in Colombia. Health Sci Rep. 2022;5(3):e640.
19. Chol YB, Lim KS. Therapeutic laparoscopy for abdominal trauma. Surg Endosc. 2003;17(3):421–7.
20. Grushka J, Ginzburg E. Through the 10-mm looking glass: advances in minimally invasive surgery in trauma. Scand J Surg. 2014;103(2):143–8.
21. Agha RA, Mathew G, Rashid R, Kerwan A, Al-Jabir A, Sohrabi C, Franchi T, Nicola M, Agha M. Revised preferred reporting of case series in surgery (PROCESS) guideline: an update for the age of artificial intelligence. Premier J Sci. 2025;10:100080.

