Aswan University Medical Journal, volume 4 / No.1/ June 2024 (84-93) Online ISSN: **2735-3117**

ORIGINAL ARTICLE

Outcome of laparoscopy in blunt abdominal trauma

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ABSTRACT

Keywords: Laparoscopy; Laparotomy; Abdominal Trauma, Trauma Score Operative Time

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Background: Among cases who have had poly trauma, abdominal trauma is an avoidable cause of mortality. This trial aimed to compare, assess and manage abdominal trauma by using two different surgical techniques laparoscopy and laparotomy; to compare the safety and effectiveness of laparotomy versus laparoscopy on blunt abdominal trauma (BAT). **Methods:** This prospective comparative trial was performed on 120 patients clinically diagnosed with abdominal trauma, aged 5–70 years, patients with BAT. Patients were allocated equally into two Groups: (Group A): 60 cases underwent laparoscopic surgical procedure for abdominal trauma. (Group B): 60 cases underwent laparotomy surgical procedure for abdominal trauma. All cases were subjected to general examination, preoperative scoring system, Injury severity score (ISS), laboratory investigations, radio graphic investigations, and trauma data. **Results:** There is a highly significant variation between both groups regarding pre-operative Injury severity score operative time, post-operative days in ICU, hospital stay, time to pass gas, post-operative complications and mortality. **Conclusions:** As a reliable and safe diagnostic and therapeutic method for abdominal injuries, capable of decreasing the incidence of laparotomy and linked with decreased morbidity and mortality, laparoscopy has been identified as a viable substitute for laparotomy.

INTRODUCTION:

Trauma is the primary cause of mortality during the initial half of the human lifespan, and ranks fourth among all causes of death in the population. Additionally, abdominal injuries comprise 9–14.9% of all injury cases. In patients with poly trauma, abdominal trauma (AT) is one of the avoidable causes of mortality, and laparotomy has always been the treatment of choice [1].

Triage of patients with AT is significantly influenced by routine diagnostic procedures including peritoneal lavage, angiography, computer tomography, ultrasonography, and peritoneal ultrasound. AT cases are hemodynamically unstable and necessitate surgical intervention without delay. They must be transported to the operating room without any

additional examinations or procedures. Twenty percent of all trauma procedures are conducted as a result of AT [2].

Nevertheless, it would be more advisable to prevent unnecessary laparotomies due to the morbidity associated with them, which varies between 20 and 40 %. When performed by experienced surgeons under hemodynamically stable settings, laparoscopy is a safe and efficacious technique for the therapy of patients who have sustained abdominal injuries [3]. Nontherapeutic laparotomy for hemodynamically stable patients has decreased as a result of selected non-operative care and imaging technology advancements [4].

Blunt abdominal trauma (BAT) can be precisely and efficiently treated with laparotomy; but, this approach entails a large incision, has the potential for nontherapeutic laparotomy, and poses a sustained risk of bowel blockage. Laparoscopy can reduce postoperative pain, help to avoid nontherapeutic laparotomies, and diminish the likelihood of bowel obstruction. Conversely, laparoscopy incurs higher procedural expenses and may result in extended completion times for surgeries [5].

There is evidence supporting the utilization of laparoscopy in individuals who are hemodynamically stable, for both the diagnosis and treatment of BAT. Laparoscopy is related with reduced intraoperative blood loss, perioperative mortality, shorter hospital and intensive care unit (ICU) stays, postoperative pain and complications, and prevents nontherapeutic laparotomy [6]. Multiple retrospective case series in children provide evidence that laparoscopy can be an effective treatment option for abdominal trauma. Comparing patients undergoing laparoscopy versus laparotomy, a few small studies have found comparable mortality and no instances of missing injury [7].

This study aims to compare, assess and manage abdominal trauma by using two different surgical techniques laparoscopy and laparotomy; to compare the safety and effectiveness of laparotomy versus laparoscopy on BAT.

Patients and Methods:

This prospective comparative trial was performed on 120 patients clinically diagnosed with abdominal trauma, aged 5–70 years, with BAT, and had surgical indications by diagnostic abdominal paracentesis or imaging findings and were hemodynamically stable prior to surgery. The study was performed in the emergency unit of the Department of General Surgery, Faculty of Medicine at Aswan University Hospital.

The patients or their relatives provided written informed consent. Institutional ethics approval was obtained before the start of the study. All consecutive patients selected from emergency unit of the Department of General Surgery, Faculty of Medicine at Aswan University Hospital who underwent laparoscopy versus laparotomy between January 2021 and January 2022 for treating abdominal trauma postoperative follow-up were included in this trial.

Exclusion criteria were hemodynamic instability, prior diagnostic or therapeutic abdominal surgeries, severe peritonitis that needed emergency surgery, and other severe damages (e.g. thoracic, cerebral traumas).

Patients were allocated equally into two Groups: (Group A): underwent laparoscopic surgical procedure for abdominal trauma. (Group B): underwent laparotomy surgical procedure for abdominal trauma.

General Examination: demographics: Age, residence, sex, and arrival time. Clinical data: Initial ABCDE assessment (airway and cervical spine control; breathing; circulation; dysfunction of the central nervous system; and exposure), followed by regional head and neck; chest; abdomen; extremities; and back examination.

Preoperative Scoring System:

Injury Severity Score (ISS):

Commonly used in traumatology, the ISS is a scoring system with values ranging from 0 to 75, which rises in accordance with severity (higher score represents higher severity of injury, and, therefore, increase the mortality). An Abbreviated Injury Scale (AIS) score is allocated to every injury in order to determine the ISS. In the calculation of the ISS, only the highest AIS score from everybody area is considered. For obtaining the ISS, the squares of the scores associated with the three body parts that had the most severe injuries are summed together; and, therefore, The ISS is calculated as the sum of the squares of the greatest degrees of AIS for each of the three most severely injured body parts. An automatic ISS of 75 is allocated to the patient in case of a level 6 injury. ISS values of 16 or above are typically considered poly trauma [8].

Laboratory examinations such as Cross-matching, coagulation profile, and complete blood count were performed.

Radiographic examinations: pelvi-abdominal ultrasound, Plain chest X-ray, and computed tomography in some stable cases.

Trauma information: We recorded the time of injury, abdominal injury pattern, mechanism of trauma, and associated injuries.

Laparoscopic Surgical Technique (Diagnostic): A 10-mm trocar was first placed through an infraumbilical incision. Then, a pneumoperitoneum was established by inducing and maintaining pressure (12 mmHg) using carbon dioxide. For abdominal investigation, a 10-mm telescope positioned at a 30-degree angle was typically used. In addition, two 5-mm laparoscopic ports were positioned in the right iliac fossa and right upper quadrant (paramedial region) under direct view. When necessary, mirror-image ports were positioned on the left side. A search for blood, bile, or intestinal contents was conducted upon laparoscope insertion. An assessment of the small intestine from Treitz's ligament to the ileocecal valve, an examination of the spleen and liver for bleeding, and an evaluation of the hollow viscus damage from stomach to rectum constituted the standard examination. Segments of the small intestine and mesentery were lifted and evaluated by means of atraumatic bowel graspers. The reverse sides were observed in a similar manner by crossing the graspers.

Laparoscopic Surgical Technique (Therapeutic): For specific indications, laparoscopy was performed on hemodynamically stable patients with BAT. These indications included clinical findings, suspected injuries to hollow viscus (as indicated by clinical or radiological findings) or the diaphragm, failed Non Operative Management (NOM) for spleen injuries with or without Trans Arterial Embolization (TAE), failed NOM for liver injuries with or without TAE, and isolated accumulation of unknown-origin intra-abdominal fluid on CT films. In the case of solid organ damage (spleen or liver), failed NOM was defined as the presence of peritonitis or the need for continuous blood transfusion to maintain hemodynamic stability. In addition to meeting the requirements and requiring fluid resuscitation to maintain hemodynamic stability, patients having laparoscopy could not have any contraindications to pneumoperitoneum (cardiopulmonary insufficiency or severe head injury).

Laparotomy Surgical Technique:

The abdominal wall is exposed in a slice-wise fashion, with a transverse or longitudinal incision made into the skin and subcutaneous tissue, followed by careful hemostasis of the bleeding. Aponeurosis was also severed. Intra-abdominal organs were examined and assessed for pathology; internal reproductive and other intra-abdominal/pelvic organs were also examined.

As a result of the slice-wise closure of the surgical incision, suturing is conducted on each layer individually. Tissues are sampled intraoperatively for histopathologic examination. There are two potential methods by which the procedure can be executed: laparotomy or laparoscopy. A global trend exists toward a decline in the quantity of laparotomies performed. Surgical procedures are performed with least invasive techniques preferred when contraindications are absent.

Postoperative:

All research participants were assigned to one of two groups: laparotomy or laparoscopy. Every surgery was executed under general anesthesia by a surgeon who has equal proficiency in both modern laparoscopic methods and open surgeries. A comparison was made between the two groups in terms of the length of hospital stay (LOS) and the outcomes. The LOS was determined by deducting the time between the admission and discharge dates. The severity of intraabdominal injuries was described using the grading system established by the American Association for the Surgery of Trauma (AAST). In patients with stable BAT, the injury mechanism, surgical technique, conversion, duration of ICU and LOS, and outcomes were documented and analyzed. Review was conducted on the main complications with Clavien–Dindo (CD) Grades 3–5. For both groups, demographics, the site of the injury, comorbidities, and complications were documented.

Statistical analysis

SPSS v27 (IBM©, Armonk, NY, USA) was used for statistical analysis. Histograms and the Shapiro-Wilks test were utilized to assess the normality of the data distribution. Qualitative variables were expressed as frequency and percentage (%) and Chi-square test or Fisher's exact test (when appropriate) were used for the analysis. Quantitative non-parametric data were expressed as the median and interquartile range (IQR) and were analyzed by Mann Whitney-test. Quantitative parametric data were expressed as mean and standard deviation (SD) and unpaired student t-test was used for the analysis. A two-tailed P value < 0.05 was deemed statistically significant.

Results:

Regarding age, gender, BMI and the used surgical approach, no significant variation was reported between both groups. **Table 1**

Table 1: Demographic data of patients included in the study as regard to age, Gender, and BMI and Diagnostic or Therapeutic in Laparoscopy and Laparotomy Approaches

		Laparoscopy group	**Laparotomy group**	**P-value**
		No. = 60	**No. = 60**	
Age		36.68 ± 9.57	38.16 ± 11.19	0.723
Gender	**Female**	26 (43.4%)	36 (60 %)	0.765
	Male	34 (56.6%)	24 (40 %)	
	Median	35.5	31.5	
Diagnostic		20 (33.34 %)	24 (40 %)	0.679
Therapeutic		40 (66.67 %)	36(60 %)	

Data was presented as mean ±SD and number (%).

A high significant variation was reported between both groups as regard pre-operative injury severity score. **Table 2**

Table 2: Preoperative Injury severity score of Included Groups

	Laparoscopy N = 60	**Laparotomy N = 60**	**P Value**
Injury severity score	24.56± 3.67	9.41 ± 4.65	**< 0.001***

Data are presented as mean ± SD, * = Highly Significant

Regarding the injured organs, mode of trauma, and the surgical procedure done, no significant difference variation was reported between both groups. **Table 3**

Table 3: The mode of trauma, injured organ and the procedure made.

		Laparoscopy group		**Laparotomy group**		**P-value**
		No.	**%**	**No.**	**%**	
Mode of trauma	**Road Traffic Accident**	38	63.3%	30	50.0%	0.099
	Fall From Height	12	20.0%	24	40.0%	
	Assault	10	16.67%	6	10%	
Injured organ	**Spleen**	37	61.67%	38	63.3 %	0.252
	Bleeding with no organ injured	9	15%	10	16.67 %	
	Liver	14	23.3%	12	20 %	
Procedure	**Splenectomy**	30	50.0%	38	63.3 %	0.339
	Bleeding control	17	28.33%	22	36.67%	
	Conversion into laparotomy	13	21.67%	0	0.00 %	

Data was presented as mean ±SD and number (%). *: Chi-square test; Non-significant (NS): P-value >0.05; Significant (S): P-value <0.05; highly significant (HS): P-value< 0.01.

A high significant variation was reported between both groups regarding operative time, time to pass gas, post-operative days in ICU, and hospital stay. And the table illustrates that laparoscopy procedure was associated with less post-operative stay in ICU, time to pass flatus and hospital stay compared to laparotomy procedure despite the longer operation time of laparoscopy. **Table 4**

Table 4: Operative time, post operative days in ICU, time to pass gas and hospital stay.

		Laparoscopy group	**Laparotomy group**	**P-value**
		N = 60	**N = 60**	
Operative time	**Mean±SD**	150.84 ± 24.75	123.28 ± 21.61	**< 0.001**
	Range	110 – 198	90 – 160	
Post-operative days in ICU	**Mean±SD**	1.12±0.87	3.99±1.95	**< 0.001**
	Range	1 – 3	2 – 6	
Time to flatus	**Mean±SD**	1.91±0.79	3.59±0.94	**< 0.001**
	Range	1 – 3	2 – 5	
Hospital stay	**Mean±SD**	7.58±3.49	15.97 ± 1.79	**< 0.001**
	Range	4 – 12	13 – 19	

Data are presented as mean ± SD. Non-significant (NS): P-value >0.05; Significant (S): P-value <0.05; highly significant (HS): P-value< 0.01.

Regarding post-operative complications and mortality, a significant variation was reported between both groups; and the table illustrates that laparoscopy procedure was related to less post-operative complications and laparotomy procedure. **Table 5**

Table 5: The post operative complications and mortality

		Laparoscopy group		**Laparotomy group**		**P-value**
		No.	**%**	**No.**	**%**	
Complications	**No**	56	93.4%	44	73.33%	**0.013**
	Respiratory tract infections	4	6.6 %	8	13.3 %	
	Wound infection	0	0.0%	2	3.4 %	
	Deep venous thrombosis	0	0.0%	6	10.0%	
Mortality	**No**	60	100.0%	56	93.3%	**0.049**
	Yes	0	0.0%	4	6.67%	

Data are presented as number (%). *: Chi-square test, Non-significant (NS): P-value >0.05; Significant (S): P-value <0.05; highly significant (HS): P-value< 0.01.

Discussion

In patients with poly trauma, abdominal trauma is one of the avoidable causes of mortality, and laparotomy has always been the treatment of choice. Nevertheless, it would be more advisable to prevent unnecessary laparotomies due to the morbidity associated with them, which varies between 20 and 40 %. Nontherapeutic laparotomy for patients who are hemodynamically stable has decreased as a result of developments in selected non-operative management and imaging technologies. Additionally, research has demonstrated that the incidence of non-therapeutic laparotomy has reduced considerably since the introduction of laparoscopy [6, 9]. Furthermore, whether used for diagnostic or therapeutic purposes, laparoscopy is associated with shorter hospital stays, less pain, and faster recovery periods in comparison to laparotomy [1].

Prior research on this subject has, as far as we are aware, concentrated mostly on the diagnostic use of laparoscopy in trauma settings. Conversely, research comparing laparotomy versus therapeutic laparoscopy in terms of efficacy and safety remains few. Furthermore, the variability of the existing outcomes has been exacerbated by the fact that different surgical procedures have been performed by surgeons in different institutions. Therefore, we wanted to assess the safety and effectiveness of laparoscopy and laparotomy on penetrating or BAT in the present trial [10].

Comparable to open techniques, laparoscopic procedures have low complication rates, relative morbidity and mortality, and missed injury rates. Furthermore, a diverse array of intraabdominal pathologies, such as injuries to the intestine, spleen, liver, diaphragm, and pancreas, can be effectively managed laparoscopically. [11].

In the present study, regarding pre-operative injury severity score, a high significant variation was reported between both groups.

A previous meta-analysis found that previous studies [9][6, 12] evaluated the severity of the condition by the abbreviated injury scale/abdominal trauma index, ISS, or new ISS, while other trial [13] did not mention the severity scores. Furthermore, a significant disparity in disease severity was seen between the laparoscopy and laparotomy groups in two separate trials [6]. With the exception of two studies that considered a subset of hemodynamically

unstable cases, the vast majority of papers exclusively focused on hemodynamically stable cases [14].

Almost all reports involved only hemodynamically stable patients, except for two studies Kurtulus et al. [15] and Boni et al. [16] which included a certain percentage of hemodynamically unstable patients.

Depending on the group that the cases were assigned, in Hajibandeh et al. [17], they were treated by laparoscopy and laparotomy management using postoperative RTS score. Patients that demonstrated leukocytosis with left shift were removed in laparoscopy group, as compared to laparotomy group.

Laparoscopy decreased the rate of non-diagnostic laparotomies and was beneficial in the treatment of patients with BAT and penetrating injuries, with an overall failure rate of 4%, according to a research by Huang et al. [18].

Similar findings were also shown by Liberati et al. [19] in paediatric cases who experienced penetrating and BAT; they concluded that laparoscopy is underused in abdominal trauma cases.

The mean of operative time of laparoscopy group were varied between min and max range 110 - 198 minutes, while; The mean of operative time of laparotomy group was statistically highly significant differences. The mean of hospital stay in laparotomy group was statistically highly significant differences.

According to the pediatric trial by Butler et al. [5], 21% of open procedures and 28% of laparoscopic treatments were nontherapeutic. By employing laparoscopy, 61 negative laparotomies were avoided (8% of all cases), resulting in avoiding the associated morbidity of laparotomy, which included postoperative pain, higher wound complications, and long-term risk of intestinal blockage. If exploratory laparotomy had been substituted with diagnostic laparotomy initially, an extra 106 nontherapeutic laparotomies (15% of all cases) may have been prevented. If laparoscopy indeed reduces complication rates and reduced LOS, this could have huge potential benefits, both for the health care system and individual cases. Nevertheless, therapeutic laparoscopic operations are sometimes accompanied by increased operative expenses and perhaps extended operating durations. Laparoscopy may be impracticable at extremely busy trauma centers with a large volume of operations. Operative time is not accounted for in the NTDB; therefore, a direct evaluation of this is not feasible; A meta-analysis of adult cases with trauma, on the other hand, found that laparoscopy reduced operation time, while an institutional research from a single hospital found no difference between laparoscopy and laparotomy in terms of operative time [20].

Regarding the mode of trauma, injured organs and the surgical procedure (Conversion into laparotomy) done, no significant variation was found between both groups.

Similar to previous trials on BAT in children, the rate of conversion in our trial was 39% [21]. This conversion rate is significantly greater than that of other frequently executed laparoscopic operations, such cholecystectomy or appendectomy, which have a rate ranging from 8% to 12% and from 1% to 6% respectively. This is possibly due to the fact that numerous surgeons consider laparoscopy to be a diagnostic surgery rather than a curative one for treating BAT [22].

In this study, the percentage complication of laparoscopy group shows statistically significant differences.

Wang et al. [23] reported an average conversion rate value of 25.0% (range from 0 to 45.1%) from laparoscopy to laparotomy. The age of the cases spanned from 26 to 57 years, with males comprising 76.9% of the population.

Our present study showed that the percentage mortality of laparoscopy group shows statistically significant differences.

Laparoscopy accelerates patients' return to regular activities, enhances their quality of life, and reduces hospital stays and peri-operative complications significantly. The most often seen consequence in this analysis was wound infection, which occurred at an incidence of 2.53% overall in the laparoscopy group, which was much lower than that of laparotomy. This finding aligns with previous research that has demonstrated a reduction in wound infections subsequent to laparoscopic surgeries, including cholecystectomy [25] and appendectomy [24]. This could be attributed to the decreased tissue trauma and surgical stress put on the patient during minimally invasive procedures. Several reasons have been implicated in this process, including a more minor incision, less surgical trauma, diminished postoperative pain, quicker mobilization, a pro inflammatory response that is less apparent in comparison to open surgery, and improved maintenance of systemic immune function [26]

However, Wang et al. [1] showed that in the laparotomy group, 208 fatalities were recorded, compared to 123 in the laparoscopy group. An analysis of the mortality incidence rates between the groups revealed no significant variation [5.74 vs. 8.17%, 95%CI (−0.03, 0.00), RD −0.01, $p = 0.09$], with moderate heterogeneity (I2 = 38%)

This is consistent with Cherry et al. [27] who documented that is laparotomy associated with high rates of postoperative complications and mortality than laparoscopy.

According to the findings of Hajibandeh et al. [28], no reduction in operation time was observed in the laparoscopy group. In our investigation, the absence of complications resulting from missed injuries in any patients further substantiated the unique diagnostic utility of laparoscopy when performed following the usual exploratory operation protocol. We did observe a longer hospital stay in comparison to the research by Saurav et al. [9]. This may have been the result of post-operative complications that led to the extended stays.

The current study also has some limitations. First, relatively small sample size. Second, selection bias may have occurred and the generalizability of our findings to other forms of abdominal trauma may have been diminished as the cases in the laparoscopy group were chosen based on the surgeons' evaluation findings and had no other significant trauma. Finally, the follow-up duration was short.

Conclusion

As a reliable and safe diagnostic and therapeutic method for abdominal injuries, capable of decreasing the incidence of laparotomy and linked with decreased morbidity and mortality, laparoscopy has been identified as a viable substitute for laparotomy.

Financial support and sponsorship: Nil

Conflict of Interest: Nil

Funding: Nil

References:

1. Wang J, Cheng L, Liu J, Zhang B, Wang W, Zhu W, et al. Laparoscopy vs. Laparotomy for the management of abdominal trauma: A systematic review and meta-analysis. Front Surg. 2022;9:817-34.

2. Demetriades D, Velmahos G. Technology-driven triage of abdominal trauma: the emerging era of nonoperative management. Ann Review Med. 2003;54:1-15.

3. Sermonesi G, Tian BW, Vallicelli C, Abu-Zidan FM, Damaskos D, Kelly MD, et al. Cesena guidelines: WSES consensus statement on laparoscopic-first approach to general surgery emergencies and abdominal trauma. World J of Emerg Surg. 2023;18:57-63.

4. Kanlerd A, Auksornchart K, Boonyasatid P. Non-operative management for abdominal solidorgan injuries: A literature review. Chinese J Traumatol. 2022;25:249-56.
5. Butler EK, Mills BM, Arbabi S, Groner JI, Vavilala MS, Rivara FP. Laparoscopy compared with laparotomy for the management of pediatric blunt abdominal trauma. J Surg Res. 2020;251:303-10.
6. Lin HF, Chen YD, Chen SC. Value of diagnostic and therapeutic laparoscopy for patients with blunt abdominal trauma: A 10-year medical center experience. PLoS One. 2018;13:193-9.
7. Ki Y-J, Jo Y-G, Park Y-C, Kang W-S. The Efficacy and Safety of Laparoscopy for Blunt Abdominal Trauma: A Systematic Review and Meta-Analysis. J of Clin Med. 2021;10:1853-60.
8. Rapsang AG, Shyam DC. Scoring systems of severity in patients with multiple trauma. Cirugía Española 2015;93:213-21.
9. Chakravartty S, Sarma DR, Noor M, Panagiotopoulos S, Patel AG. Laparoscopy has a therapeutic role in the management of abdominal trauma: A matched-pair analysis. Int J Surg. 2017;44:21-5.
10. Gao Y, Li S, Xi H, Bian S, Zhang K, Cui J, et al. Laparoscopy versus conventional laparotomy in the management of abdominal trauma: a multi-institutional matched-pair study. Surg Endosc. 2020;34:2237-42.
11. Omori H, Asahi H, Inoue Y, Tono C, Irinoda T, Saito K. Selective application of laparoscopic intervention in the management of isolated bowel rupture in blunt abdominal trauma. J Laparoendosc Adv Surg Tech A. 2003;13:83-8.
12. Birindelli A, Martin M, Khan M, Gallo G, Segalini E, Gori A, et al. Laparoscopic splenectomy as a definitive management option for high-grade traumatic splenic injury when non operative management is not feasible or failed: a 5-year experience from a level one trauma center with minimally invasive surgery expertise. Updates Surg. 2021;73:1515-31.
13. Shams M, Elyasi A. Comparison of diagnostic laparoscopy and exploratory laparotomy in the management of patients with penetrating abdominal trauma. Babol Univ Medical Sci. 2021;23:222-8.
14. Chestovich PJ, Browder TD, Morrissey SL, Fraser DR, Ingalls NK, Fildes JJ. Minimally invasive is maximally effective: Diagnostic and therapeutic laparoscopy for penetrating abdominal injuries. J Trauma Acute Care Surg. 2015;78:1076-85.
15. Kurtulus I, Culcu OD, Degerli MS. Which is more effective: Laparoscopic or open partial cholecystectomy? J Laparoendosc Adv Surg Tech A. 2022;32:476-84.
16. Boni L, Benevento A, Rovera F, Dionigi G, Di Giuseppe M, Bertoglio C, et al. Infective complications in laparoscopic surgery. Surg Infect. 2006;7 109-11.
17. 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.
18. Huang GS, Chance EA, Hileman BM, Emerick ES, Gianetti EA. Laparoscopic splenectomy in hemodynamically stable blunt trauma. Jsls. 2017;21:23-9.
19. Liberati A, Altman DG, Tetzlaff J, Mulrow C, Gøtzsche PC, Ioannidis JP, et al. The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate health care interventions: explanation and elaboration. J Clin Epidemiol. 2009;62:1-34.
20. Evans PT, Phelps HM, Zhao S, Van Arendonk KJ, Greeno AL, Collins KF, et al. Therapeutic laparoscopy for pediatric abdominal trauma. Journal of pediatric surgery. 2020;55:1211-8.

21. Evans PT, Phelps HM, Zhao S, Van Arendonk KJ, Greeno AL, Collins KF, et al. Therapeutic laparoscopy for pediatric abdominal trauma. J Pediat Surg. 2020;55:1211-8.
22. Gosemann J-H, Lange A, Zeidler J, Blaser J, Dingemann C, Ure BM, et al. Appendectomy in the pediatric population—a German nationwide cohort analysis. Langenbeck's Arch Surg. 2016;401:651-9.
23. Wang J, Cheng L, Liu J, Zhang B, Wang W, Zhu W, et al. Laparoscopy vs. Laparotomy for the Management of Abdominal Trauma: A Systematic Review and Meta-Analysis. Front Surg. 2022;9:817134.
24. Zhang J, Wang M, Xin Z, Li P, Feng Q. Updated evaluation of laparoscopic vs. Open appendicectomy during pregnancy: A systematic review and meta-analysis. Front Surg. 2021;8:720-51.
25. Kurtulus I, Culcu OD, Degerli MS. Which Is More Effective: Laparoscopic or Open Partial Cholecystectomy? J Laparoendosc Adv Surg Tech A. 2022;32:476-84.
26. Shabanzadeh DM, Sørensen LT. Laparoscopic surgery compared with open surgery decreases surgical site infection in obese patients: a systematic review and meta-analysis. Ann Surg. 2012;256:934-45.
27. Cherry RA, Eachempati SR, Hydo LJ, Barie PS. The role of laparoscopy in penetrating abdominal stab wounds. Surg Laparosc Endosc Percutan Tech. 2005;15:14-7.
28. Hajibandeh S, Hajibandeh S, Gumber AO, Wong CS. Laparoscopy versus laparotomy for the management of penetrating abdominal trauma: a systematic review and meta-analysis. International Journal of Surgery. 2016;34:127-36.