

Laparoscopy in trauma. When and how to use this approach?

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SUMMARY

Introduction: Trauma is one of the leading causes of death and disability worldwide. Laparoscopy has shown to have an advantage over traditional surgical techniques in several areas; however, its use in the evaluation and treatment of trauma has been scarce.

Material and Methods: A recent literature search of the relationship between laparoscopic surgical techniques and trauma was performed in PubMed, Cochrane Library, EBSCO Host, IMBIOMED and Medigraphic databases (words MESH *laparoscopy*, *minimally invasive* and *trauma*).

Clinical vignette: An 80-year-old man was admitted with a history of being run over. He was diagnosed with hypovolemic shock grade IV, fractures of the right costal arches and fracture of the pelvis Tile B. He required external fixation and intensive care unit management; despite this, he persisted with hemodynamic instability and diagnostic laparoscopy was performed.

Discussion: A meticulous initial evaluation is necessary; the lack of a diagnosis of certainty requires further investigation; treatment should be individualized and there should be no obvious indication for laparotomy.

Conclusions: There is evidence in the literature to affirm that laparoscopy is effective and sometimes superior to conventional laparotomy for the evaluation and treatment of trauma victims.

KEY WORDS: laparoscopy, minimally invasive, trauma.

INTRODUCTION

Globally, trauma contributes 10% of deaths and disabilities in people (95% male) aged 5 to 44 years; in the Americas alone, there were around 150,000 deaths due to trauma in 2010. In Mexico, accidents have been the fourth leading cause of death since the 1950s: 36,194 deaths occur each year because of accidents and 27,213 due to injuries from other causes. In Mexico City alone, statistics report 1,729 deaths as a result of accidents and 1,084 deaths due to injuries from other causes each year. These figures show that trauma and its consequences are an epidemiological problem whose attention implies sufficient medical services and the necessary *expertise* to improve the prognosis of the population that is a victim of trauma.¹⁻¹¹

Surgical techniques with minimally invasive access have been shown to have several advantages over traditional techniques in several areas (reduction of perioperative mortality by 4.7%, reduction of perioperative morbidity by 7.9%, better trans-surgical visibility, lower magnitude and duration of post-surgical pain, earlier mobilization out of bed, earlier initiation of oral diet, lower risk of surgical site infection, lower risk of incisional hernia, lower risk of adhesion development, hospital stay time of 5-11 vs. 9-17 days, earlier return to daily activities and lower final economic impact). Despite this, the incursion for the evaluation and treatment of trauma has been late and scarce.¹⁻⁸

We conducted a review of the surgical literature to ascertain the current position regarding the use of laparoscopy for the evaluation and treatment of trauma patients with the purpose of building consensus to guide decision making regarding the use of laparoscopy in trauma.

MATERIALS AND METHODS

A search of surgical literature in English and Spanish on the relationship between surgical techniques with minimally invasive access and trauma was carried out in the databases PubMed, Cochrane Library, EBSCO Host, IMBIOMED and Medigraphic, using the words MESH *laparoscopy*, *minimally invasive* and *trauma* in a cross-referenced manner with focus on the indications for laparoscopic surgery in trauma of the last 15 years. Thirty-one articles were obtained, including a meta-analysis.

CLINICAL VIGNETTE, RESULTS AND DISCUSSION

An 80-year-old man, diabetic and hypertensive of long evolution, from another hospital, transferred by his relatives to the emergency department in a wheelchair, referring a history of being run over on a high-speed road; kinematics of the trauma and time of evolution are unknown. The patient was admitted to the shock room with A) patent airway without cervical protection, B) spontaneous ventilation without pleuropulmonary syndromes, C) pale, hypotensive, without evidence of external bleeding, D) Glasgow Coma Scale 15, E) exposed, explored and covered to maintain euthermia. On physical examination we found him with T/A 80/60mmHg, HR 66x', FR 29x' and Temp 36.0°C, conscious, oriented and cooperative, pale, normocephalic with multiple dermabrasions and ecchymosis on skull and face, isometric and normoreflexic pupils, left otorrhagia, permeable nares with hematic remains inside, oral cavity with discreetly dehydrated mucosa, neck with central and movable trachea, without jugular ingurgitation, normolinear thorax with symmetrical amplexion and amplexation movements, vesicular murmur present, heart sounds with good rhythm and frequency, decreased in intensity and pulmonary systolic murmur, flat abdomen with peristalsis present, soft, not painful, without signs of peritoneal irritation, pelvis tilting and painful to palpation, extremities with multiple dermabrasions and ecchymosis.

The evaluation of trauma patients always represents a diagnostic and therapeutic challenge. This evaluation should take into account the individual characteristics of each patient and the resources available in the institution, considering that the most important thing is to identify life-threatening injuries and establish a timely surgical indication. It is also necessary to keep in mind:

- The abdomen occupies third place in frequency among the regions affected by trauma (20%) and is often associated with hemodynamic instability (15.9-50.7%) and alterations in consciousness (25-69.3%), which cause high mortality (25-65%) because they hinder the establishment of a definitive diagnosis (47%) and the initiation of timely therapeutic measures (17%).
- About 20% of surgical interventions for trauma are due to abdominal injuries, the organs most frequently affected in closed trauma are spleen (40-55%) and liver (35-45%) and retroperitoneal hematomas (15%); in open trauma the gastrointestinal tract is involved (95%).
- The classification of abdominal trauma as closed or open allows "predicting" the most probable visceral injury and the clinical evaluation provides information to make decisions for surgical management; it is essential to have a high index of suspicion in order not to miss unnoticed injuries, since in up to one out of five patients with acute hemoperitoneum the initial abdominal examination is normal and one out of three patients with few manifestations in the initial examination will require emergency laparotomy.

These characteristics imply that once the patient's hemodynamic stability has been corroborated, complementary studies are necessary to determine the best course of action to follow (Table I).¹⁻²⁷

TABLE I. Indications for requesting additional studies in hemodynamically normal patients.

Alterations of consciousness
Sensitivity alterations
Injuries to adjacent structures
Prolonged loss of contact
Seat belt sign
Doubtful" physical examination

The main diagnostic concerns are: 1) overlooking a hepatic, splenic, or retroperitoneal lesion during the initial workup, especially in patients with multiple lesions, normal hemodynamic parameters, and concomitant cranioencephalic, spinal, and/or substance abuse trauma, and 2) demonstration of gastrointestinal tract involvement, diaphragm or pancreas is difficult and false negative results can have dire consequences, but if laparotomies are routinely performed, the morbidity rate and costs are unnecessarily increased.^{13, 14, 18, 20, 21, 25, 27}

The results of paraclinical studies: hemoglobin 8.3g/dL, hematocrit 24.1%, platelets 43,000/mm³, leukocytes 26,700/mm³ (neutrophils 88%), prothrombin time 18.9sec, partial thromboplastin time 64sec, international normalized ratio 1.62, glucose 624mg/dL, creatinine 1.79mg/dL, urea nitrogen 21mg/dL, urea 44.94mg/dL, sodium 128.1mEq/L, potassium 4.83mEq/L, chlorine 107.3mEq/L, general urine examination without significant erythrocyturia. Imaging studies revealed: lateral radiograph of cervical spine with preserved Denis lines, without evidence of bony continuity solutions or joint incongruence; anteroposterior radiograph of thorax with central air column, mediastinum without alterations, free diaphragmatic angles, expanded lungs, fracture of XI and XII right costal arches, soft tissues without alterations; anteroposterior radiograph of the pelvis with bony continuity solutions at the sacrum level, left ischiopubic branch and left iliopubic branch, without joint incongruence; initial and secondary FAST (30min later) without free intraperitoneal fluid.

The following diagnoses were integrated: systemic inflammatory response syndrome, grade IV hypovolemic shock and acute traumatic coagulopathy secondary to polytrauma, fractures of the XI and XII right costal arches and Tile B pelvis fracture, which required closed reduction with immediate external fixation and transfer of the patient to the intensive care unit. Despite the implementation of therapeutic and support measures, the patient persisted with hemodynamic instability.

The use of minimally invasive approaches in these cases makes it possible to determine the existence of visceral involvement and to rule out other associated or pre-existing lesions (sensitivity 80-100%, specificity 73-100% and accuracy 50-100%). Although ultrasound and tomography can demonstrate the presence of free intraperitoneal fluid, they do not always allow differentiating whether this fluid accumulated as a consequence of the efforts to resuscitate the patient or whether it comes from a visceral disruption; the laparoscopic approach not only allows direct visualization of the abdominal contents, but also permits the targeted collection of intraperitoneal fluid samples. Heselson's (1970) original indication for determining peritoneal penetration of tangential wounds remains valid: surgical techniques with minimally invasive approach have demonstrated greater specificity and sensitivity for identifying it (≈100%)-as well as diaphragmatic lesions-compared with CT and FAST, although laparotomy is still considered the first-choice conduct to follow in patients with hemodynamic instability.^{13, 14, 17-20, 25-28}

Although diagnostic peritoneal lavage can obviate some of the disadvantages of imaging studies and constitutes a middle ground in terms of cost, invasiveness, sensitivity and specificity (Tables II and III), it is limited to the diagnostic setting. One of the advantages offered by laparoscopic surgical techniques is their therapeutic application with conversion rates between 0.24-50%.^{3, 10-22, 25, 26, 29-31}

TABLE II. Options for evaluating open abdominal trauma

	Physical examination	Wound digitization	Diagnostic peritoneal lavage	FAST	Computed Tomography	Laparoscopy	Laparotomy
Sensitivity (%)	95-97	71	87-100	46-85	97	50-100	-
Specificity (%)	100	77	52-89	48-95	98	74-90	-
Negative Predictive Value (%)	92	79	78-100	60-98	98	100	-

Cooperative patient	+	-	-	-	-	-	-
Invasive	-	+	+	-	-	+	++
Hospital admission	+	+/-	-	-	-	+	+
Evaluates retroperitoneum	+/-	-	-	-	+	-	+
Workload	+	-	-	-	-	+/-	+/-
Complication rate	-	+	+/-	-	-	+	++

TABLE III. Options for evaluating blunt abdominal trauma

	Diagnostic peritoneal lavage	FAST	Computed Tomography
Advantages	Early diagnosis Speed Sensitivity 98%. Detects intestinal injury No transportation required	Early diagnosis Non-invasive Speed Repeatable Sensitivity 86-97%. No transportation required	Specific diagnosis Sensitivity 92-98%. Non-invasive
Disadvantages	Invasive Low specificity Does not evaluate diaphragm or retroperitoneum.	Dependent operator Intestinal air distortion and subcutaneous emphysema Does not evaluate diaphragm, intestine or pancreas.	Cost and time May obviate lesions in diaphragm, intestine and pancreas. Requires transporting the patient
Indication	Blunt trauma (unstable) Open trauma	Blunt trauma (unstable)	Blunt trauma (unstable)

The general surgery service offered the patient diagnostic laparoscopy. Laparoscopy was performed and there was no evidence of free fluid in the cavity, so subxiphoid (12mm) and paraumbilical (5mm) working ports were introduced to mobilize the viscera. During the examination of the cavity, a retroperitoneal hematoma was discovered with involvement of the left II and right II Sheldon zones. The volume of the lesion made it impossible to determine if it was evolutive; for this reason, a medial supraumbilical laparotomy was performed to evaluate the lesions observed and no surgical repair was necessary. The patient was discharged to the intensive care unit to continue treatment until satisfactory resolution of his clinical condition.

Kawahara (2009) et al. and Koto et al. (2016) reported a standardized system for the examination of the trauma patient by laparoscopy, there is still no consensus regarding its applications and its therapeutic benefits is still a matter of controversy.⁹⁻²³

Experts in the field seem to agree that 1) a meticulous initial evaluation is necessary in order to determine the most appropriate clinical behavior to follow, 2) the lack of a diagnosis of certainty requires further investigation, 3) treatment should be individualized according to the characteristics of the patient and the degree of injury, 4) in case of opting for this technique, there should be no obvious indication for laparotomy (Table IV) the patient should be hemodynamically stable or be stable with little resuscitation efforts (systolic blood pressure ≥ 90 mmHg) and 6) during the procedure, adhesiolysis should be supported by tomographic findings and limited to the area of interest.^{10-23, 25-27}

TABLE IV. Indications for urgent laparotomy

Blunt abdominal trauma with hypotension and FAST (+) or clinical evidence of peritoneal bleeding.
Closed or open abdominal trauma with diagnostic peritoneal lavage (+)
Hypotension with penetrating abdominal injury
Firearm projectile wound through the peritoneal cavity or visceral/vascular retroperitoneum
Evisceration
Bleeding of the stomach, rectum or genitourinary tract due to penetrating trauma.
Peritonitis
Free air, retroperitoneal air or ruptured diaphragm
Contrast computed tomography showing gastrointestinal tract rupture, intraperitoneal bladder injury, renal pedicle injury or severe visceral parenchymal injury after blunt or open abdominal trauma

The data that could constitute the consensus to guide decision making regarding the application of laparoscopy in trauma are listed:

- Indications: in blunt abdominal trauma, suspicion of solid viscera injury, discrepancy between imaging findings and clinical presentation, presence of free intraperitoneal fluid of undetermined origin, evidence of visceral lesions and impossibility to determine whether they can be subjected to conservative management, failure or complications of conservative management or lack of resources to carry it out adequately, impossibility to determine the extent of intestinal injury and its association with bleeding, ischemia or necrosis, mesenteric injury with impossibility to demonstrate concomitant intestinal ischemia or necrosis. In open abdominal trauma, suspicion of peritoneal penetration is sufficient, and in polytrauma, hemodynamic instability that improves with resuscitation.^{2, 12-20, 22, 25}
- General principles: ideally have pre-surgical tomography, a laparoscopy tray with the minimum instruments and two monitors, use of general anesthesia is suggested, insertion of endopleural probe before inducing anesthesia in patients with concomitant pneumothorax, avoid Trendelenburg position in patients with cranioencephalic trauma, measures to maintain normothermia during the procedure, administer antibiotic prophylaxis and hydric resuscitation before the procedure, pre-surgical insertion of nasogastric and urinary catheters is suggested, use of minimal pneumoperitoneum (0.5mL/min up to 9-12mmHg), the Hasson technique is recommended for the introduction of the first port in umbilical position, the position of the rest of the ports and the placement of the surgeons will depend on the specific diagnosis, carry out the systematic inspection of all the intra- and retroperitoneal organs in a clockwise direction (starting with the right upper quadrant), aspirate all the blood and clots and wash with abundant warm physiological solution.^{9, 11-15, 18, 26, 27, 29-31}
- Contraindications: absolute, inexperience and low skill, hemodynamic instability despite best resuscitation efforts (relative according to Cherkasov et al. *Vid.* Reference 11), loss of abdominal wall integrity, abdominal compartment syndrome, major vascular injury, cranioencephalic trauma with increased intracranial pressure, severe thoracic trauma, blast injuries, penetrating injuries to anus or vagina, established peritonitis or sepsis. Related: polytrauma, previous abdominal surgery, abdominal distention, pregnancy.^{11-18, 20, 22}

The potential risks of laparoscopy have been considerably reduced since the 1990s thanks to new algorithms for the application of the technique; however, it is not free of complications (0.04-11%, Table V) and perioperative mortality (0.01%).^{10, 11, 13-19, 22, 28-31}

TABLE V. Summary of possible complications of laparoscopy in trauma.

<p>Access-related complications</p> <ul style="list-style-type: none"> Bladder injury Intestinal injury Cutaneous or subcutaneous lesion Injury to solid organs Eiploic lesion Subcutaneous and extraperitoneal insufflation Vascular injury
<p>Equipment failure</p> <ul style="list-style-type: none"> Damaged light source Insufficient insufflation gas supply Software-related problems Surgical instrument malfunction
<p>Inadequate visualization of lesions</p> <ul style="list-style-type: none"> Delay in diagnosis Delay to definitive therapy Inadvertent injury Preventable re-intervention
<p>Related to indication or patient selection</p> <ul style="list-style-type: none"> Error of judgment Patient factors Procedural factors
<p>Related to insufflation</p> <ul style="list-style-type: none"> Intravascular gas embolism Hemodynamic instability Pneumothorax Subcutaneous emphysema
<p>Specific organ lesions (trans-surgical)</p> <ul style="list-style-type: none"> Bladder injury Intestinal injury Diaphragmatic injury Eiploic lesion Vascular injury
<p>Post-surgical complications</p> <ul style="list-style-type: none"> Bleeding Surgical site infection Incisional hernia Retained surgical object (1/7000 cases)

It is also necessary to have a low threshold for conversion to laparoscopic-assisted surgery to laparotomy in situations such as inadequate intraoperative visualization, patient instability, massive hemorrhage, hemorrhage not controllable by laparoscopy, deep (>3cm) liver or spleen wounds, inability to locate a bleeding lesion, and expansive splenic subcapsular hematoma or >1/3 of its surface.^{9, 15-18, 26, 29-31}

CONCLUSIONS

There is evidence in the literature to affirm that laparoscopy is effective and sometimes superior to conventional laparotomy for the evaluation and treatment of trauma victims, as it clearly provides all the benefits of

minimally invasive access procedures in terms of safety and rapid recovery, with a positive impact on surgical morbidity and hospital care costs.

REFERENCES

1. Burlew CC, Moore EE. Trauma. In: Brunickardi CF et al. Schwartz's principles of surgery. 10th ed. United States: McGraw Hill; 2015. p. 161-226.
2. Moore EE, Feliciano DV, Mattox KL. Trauma. 8th ed. United States: McGraw Hill; 2017.
3. American College of Surgeons. Trauma Committee. Advanced Trauma Life Support Program (ATLS®). Student course manual. 9th ed. United States: American College of Surgeons; 2012.
4. Ruiz O, Magaña IJ. Trauma. In: Asociación Mexicana de Cirugía General A.C./Federación Mexicana de Colegios de Especialistas en Cirugía General A.C. Tratado de cirugía general. 3rd ed. Mexico: Manual Moderno; 2017. p. 1946-2044.
5. National Autonomous University of Mexico. School of Medicine. Postgraduate Studies Division. Subdivision of Medical Specializations. Plan de Estudios del Curso de Posgrado de Alta Especialidad en Cirugía del Trauma. 2017.
6. Trueba D. How to recognize the dying patient? Acute traumatic coagulopathy (ATC), experience in a level I trauma center. Thesis to obtain the title of specialist in General Surgery. National Autonomous University of Mexico, School of Medicine, Graduate Studies Division.
7. Pérez A, Trueba D, García J, et al. Endopleural probes in nonsurgical chest trauma. Experience in a level I trauma center. *Neumol Cir Thorax* 2014; 73 (4): 229-35.
8. Perez A, Trueba D, de Rungs DR, et al. Transmediastinal lesions. Review of the literature and a view of what to do. *Neumol Cir Thorax* 2015; 74 (2): 95-101.
9. Horkan DB, Tashiro J, Wagenaar AE et al. Laparoscopy in pediatric trauma: the advancement of minimally invasive techniques for abdominal trauma. *Curr Surg Rep* 2016; 4 (11).
10. Li Y, Xiang Y, Wu N. A comparison of laparoscopy and laparotomy for the management of abdominal trauma: a systematic review and meta-analysis. *World J Surg* 2015.
11. Cherkasov M, Sitnikov V, Sarkisyan B et al. Laparoscopy versus laparotomy in management of abdominal trauma. *Surg Endosc* 2008; 22: 228-31.
12. Mansoor E, Mishra RK. Challenges in the widespread use of minimal Access surgery for the management of abdominal trauma: a primer. *World J Lap Surg* 2016; 9 (3): 122-5.
13. El-Bendary YBA, Al-Adawi J, Al-Qadhi H. The use of laparoscopy in the management of trauma patients. Brief review. *Sultan Qaboos Univ Med J* 2016; 16 (1): 9-14.
14. Uranues S, Fingerhut A. Laparoscopy for trauma: when, what, how? In: Di Saverio et al. Trauma surgery. Italy: Springer-Verlag; 2014. p. 21-34.
15. Balén H, Herrera J, Miranda C et al. The role of laparoscopy in emergency abdominal surgery. *An Sist Sanit Navar* 2005; 28 (3): 81-92.
16. Matsevych O, Koto M, Balabyeki M et al. Trauma laparoscopy: when to start and when to convert? *Surg Endosc* 2017; 10.
17. Kindel T, Latchana N, Swaroop M. Laparoscopy in trauma: an overview of complications and related topics. *Int J Crit Illn Inj Sci* 2015; 5: 196-205.
18. Ozkan OV, Justin V, Fingerhut A et al. Laparoscopy in abdominal trauma. *Curr Trauma Rep* 2016; 2: 238-46.
19. Trejo MA, Blas M, Juárez D. Treatment of abdominal trauma with colon perforation by minimal access surgery. *Mexican Association of Endoscopic Surgery* 2016; 14 (4): 179-83.
20. Justin V, Fingerhut A, Uranues S. Laparoscopy in blunt abdominal trauma: for whom? when? and why? *Curr Trauma Rep* 2017; 3: 43-50.
21. Saeed MF, Abualsel AM, Ali A et al. Laparoscopic management of penetrating abdominal trauma. *International Surgery Journal* 2017; 4 (2): 764-7.
22. Mandrioli M, Inaba K, Piccinini A et al. Advances in laparoscopy for acute care surgery and trauma. *World J Gastroenterol* 2016; 22 (2): 668-80.
23. Zafar SN, Onwugbufor MT, Hughes K et al. Laparoscopic surgery for trauma: the realm of therapeutic management. *The American Journal of Surgery* 2015.
24. Anonymous reviewer. Peer report review report 1 on "Laparoscopic-assisted approach for penetrating abdominal trauma: a solution for multiple bowel injuries". *Journal of Surgery* 2017; 37 (1): 399-400.

25. Thompson EC, Knight CJ. Modern evaluation of abdominal trauma. *Marshall Journal of Medicine* 2016; 2 (2): 38-46.
26. Engin O, Sunamak O. Diagnostic laparoscopy in abdominal trauma patients. *Ann Laparosc Endosc Surg* 2016; 1(14).
27. Uranues S, Popa DE, Diaconescu B et al. Laparoscopy in penetrating abdominal trauma. *World J Surg* 2014.
28. Mohamed M, Mansy W, Zakaria Y. Use of laparoscopy in the management of abdominal trauma: a center experience. *Egyptian J Surg* 2015; 34: 11-16.
29. Koto MZ, Matsevych OY, Aldous C. Laparoscopic-assisted approach for penetrating abdominal trauma: an underutilized technique. *Journal of Laparoendoscopic & Advanced Surgical Techniques* 2016; 0 (0): 1-4.
30. Stassen NA, Bhullar I, Cheng JD et al. Nonoperative management of blunt hepatic injury: an Eastern Association for the Surgery of Trauma practice management guideline. *J Trauma Acute Care Surg* 2012; 73 (5): 288-93.
31. Stassen NA, Bhullar I, Cheng JD et al. Selective nonoperative management on blunt splenic injury: an Eastern Association for the Surgery of Trauma practice management guideline. *J Trauma Acute Care Surg* 2012; 73 (5): 294-93.

