

Is laparoscopy still needed in blunt abdominal trauma?

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Rezumat

Mai este utilă laparoscopia în contuziile abdominale?

Laparoscopia diagnostică și terapeutică în contuziile abdominale (CA) are o utilizare limitată și chiar controversată, datorită în special progreselor făcute de explorările imagistice actuale. Scopul lucrării noastre este de a evalua rolul actual al laparoscopiei în CA. Am efectuat un studiu al articolelor publicate asupra rolului laparoscopiei în CA în Pubmed și Medline în perioada ianuarie 2000 - decembrie 2007. Articolele de chirurgie infantilă, cele referitoare la plăgile abdominale, urgențele abdominale nontraumatice, leziunile iatrogene au fost excluse. Am evaluat 66 de articole care au inclus 22 de studii clinice, 27 prezentări de cazuri, 17 puneri la punct ("review"), 2 ghiduri. Studiile clinice au însumat 343 pacienți cu CA abordați laparoscopic. Laparoscopia terapeutică a fost posibilă la 168 de pacienți (48,98%), 51 de pacienți au impus conversia (14,87%). Nu au fost leziuni omise, au fost doar 6 pacienți cu complicații (1,75%) și nu s-au înregistrat decese imputabile laparoscopiei. Indicațiile principale ale laparoscopiei diagnostice în CA sunt reprezentate de suspiciunea de leziune diafragmatică respectiv suspiciunea de leziuni ale organelor cavitare la pacienții cu examen clinic și explorări imagistice echivoce. Este indicată și în cazul pacienților cu suspiciune de leziuni traumatice viscerale la care nu se poate efectua în urgență explorări imagistice performante. În concluzie, deși puțin utilizată, dovada fiind și

numărul redus de articole publicate, laparoscopia poate fi utilă la pacienții cu CA atent selectați cu examen clinic și imagistic echivoce în scopul reducerii incidenței laparotomiilor inutile. Studii multicentrice prospective sunt necesare pentru a contura mai precis rolul laparoscopiei în CA.

Cuvinte cheie: contuzie abdominală, laparoscopie, diagnostic, terapie

Abstract

Introduction: Laparoscopy, as a minimally invasive diagnostic and therapeutic tool in blunt abdominal trauma (BAT), is not commonly used and has been shown to be controversial. The aim of this study is to assess the role of laparoscopy in the diagnosis and therapy of BAT.

Methods: A systematic review and a comprehensive literature search was performed at the U.S. National Library of Medicine site in Medline and PubMed from January 2000 to 31 December 2007. This article attempts to outline the efficacy, the indications, contraindications, surgical technique and therapeutic possibilities of laparoscopy in BAT. Pediatric surgery articles and those addressing penetrating abdominal wounds, nontraumatic abdominal emergencies and iatrogenic injuries were excluded from this review.

Results: Sixty-six articles were reviewed, which included 22 case studies, 27 case reports, 17 reviews and 2 guidelines. The reviewed articles comprised 343 patients with BAT and laparoscopic approach. Therapeutic laparoscopy was possible in 168 cases (48,98%), 51 cases were converted (14,87%), overlooked injuries were absent, 6 patients had complications (1,75%), no mortality laparoscopy-related. The main indications for laparoscopy in BAT include the confirmation of suspected diaphragmatic defects, suspected hollow viscus and

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mesenteric injuries, in patients with inconclusive clinical exams and abdominal imaging. Diagnostic laparoscopy (DL) is also indicated in patients with suspected intra-abdominal injuries when advanced emergency imaging investigations are unavailable. Laparoscopy allows the surgeon to perform hemostasis, resections, suturing, autotransfusion, etc.

Conclusion: Although is not widely used, laparoscopy could still be useful in selected patients with BAT who have equivocal findings on clinical exam and imaging investigations in order to clarify the lesional diagnosis, thus avoiding unnecessary laparotomies. Multicenter prospective studies are needed to better assess the role of laparoscopy in blunt abdominal trauma.

Key words: blunt abdominal trauma, laparoscopy, diagnosis, therapy

Introduction

Unfortunately, trauma is still the leading cause of death in people under 50 years of age (1). However, remarkable progress has been made in trauma management over the past few years that includes various specific protocols, emergence of a new surgical specialty (trauma and emergency surgery), non-operative management, damage control techniques, improved imaging investigations and minimally invasive therapy (1-4). In terms of minimally invasive therapy, as a diagnostic and therapeutic tool, laparoscopy is not as frequently applied as anticipated at the beginning of laparoscopic revolution in the '90s. According to some authors (2,5,6) laparoscopy in BAT is controversial, limited, and inconclusive as opposed to its role in penetrating abdominal trauma (PAT) and thoraco-abdominal injuries. An ideal diagnostic tool for abdominal trauma should be sensitive enough not to skip small injuries, should have a high specificity as to preclude unnecessary laparotomies (negative and non-therapeutic), it should be fast, accessible, and inexpensive (7).

Unnecessary laparotomies, missed injuries, as well as injuries diagnosed too late have significantly increased the

morbidity and mortality of abdominal trauma (2). Laparoscopy is primarily a diagnostic tool, while the therapeutic role comes second. DL is useful in stable patients, not in need of an immediate exploratory laparotomy and with unclear imaging investigations, in order to rule out the indication for laparotomy (8,9-11). Based on an extensive review of articles published between 2000-2007, this article will attempt to re-evaluate the role of laparoscopy in BAT by summarizing its indications, contraindications, surgical technique, and therapeutic possibilities.

Materials and Method

A comprehensive literature search was performed on the U.S. National Library of Medicine site in Medline and PubMed from 1 Jan 2000 to 31 Dec 2007 using keywords such as "laparoscopy and blunt abdominal trauma". All articles published during the mentioned period associated with those keywords were selected. All articles referring to pediatric surgery, penetrating trauma, nontraumatic abdominal emergencies, iatrogenic injury were excluded. The articles have been grouped based on their scientific content: original studies on patients with multiples and single organ injuries, reviews, and case reports. The clinical studies addressing the role of laparoscopy in BAT also mentioned the applications of laparoscopy in PAT. However, only the data relevant for blunt trauma was selected.

Results

97 articles from Medline/PubMed were reviewed. Thirty-seven articles were excluded. This paper reviews 66 articles that met the inclusion criteria. With the scientific content reviewed, the articles were divided in three categories shown in Table 1, 2 and 3 which also include the number of investigated patients. According to the Society of American Gastroenterologist and Endoscopic Surgeons (SAGES) classification, the articles' level of evidence are III (descriptive case series) with only one exception, a level of evidence II, a case-control study (10). 343 patients with BAT were approached using laparoscopy, with one therapeutic laparoscopy possible in

Table 1. Original studies concerning laparoscopy and BAT

Type of article	Articles (N= 17)	Patients (N= 312)	References
Use of laparoscopy in abdominal trauma	5	135	12-16
Laparoscopic management of single organ injuries in BAT			
Small bowel injuries	4	90	17-20
Splenic lesions	2	17	12, 22
Diaphragmatic injury	1	8	23
Hepatic lesions	1	25	24
Single organ injuries and laparoscopy			
diaphragmatic injuries	1	2	25
colonic lesions	1	3	26
Laparoscopic management of complications following non-operative management of liver injuries	2	32	27, 28

Table 2. Case reports of laparoscopic approach of visceral injuries following BAT and post-traumatic complications

Type of article	Articles (N=26)	Patients (N=31)	References
Management of small bowel perforations	3	4	29-31
Laparoscopic approach of gallbladder injuries	4	4	32-35
Laparoscopic splenectomy	3	3	36-38
Laparoscopic approach of distal pancreatic injuries	2	2	39,40
Laparoscopic approach of urinary bladder lesions	2	2	41,42
Decompression of abdominal compartment syndrome	1	2	43
Laparoscopic approach of diaphragmatic injuries	1	1	44
Ureteral injury	1	1	45
Laparoscopic approach of a post-traumatic diaphragmatic hernia	6	9	46-51
Laparoscopic approach of a post-traumatic splenic cyst	2	2	52, 53
Post-traumatic hernia	1	1	54

Table 3. Reviews and guidelines articles

	Articles (N=16)	References
Role of laparoscopy in abdominal trauma	4	6, 8, 11, 55
Abdominal trauma and mentioned laparoscopy	4	2, 56-58
Emergency laparoscopy	3	59-61
Diaphragmatic injuries	1	62
Post-traumatic hernia	1	63
Liver injury	1	64
Guidelines article published by EAES and SAGES	2	9, 10

48,98% patients (168/343), and 14,87% in need of conversion (51/343). 6 patients had complications (1,75%, 6/343), there were no overlooked injuries and no deaths laparoscopy-related (Table 4). Table 5 displays some data extracted from the aforementioned retrospective case studies. Within the wide range of studies referring to single organ injuries, special attention was paid to small bowel injuries (SBI). There were two articles evaluating the role of laparoscopy in SBI following BAT and another two articles assessing laparoscopy as a therapeutic tool in intestinal injuries. The results are shown in Table 6. 78 patients were laparoscopically diagnosed with SBI, 51 of them being entirely laparoscopically managed or assisted and no overlooked injuries.

Table 4. Case series and case reports

	No of cases	TL	Conversions	Complications
Case series	312	139	49	6
Case reports	31	29	2	-
Total	343	168	51	6

Diagnostic laparoscopy

The laparoscopic operative technique for abdominal trauma has some specific traits:

- it is recommended to set two instrument tables, one with laparoscopic instruments and the other with a standard laparotomy tray for an impending laparotomy (4);
- the laparoscopic instruments include a 10 mm suction-irrigation device, needle driver, an adequate insufflator, a powerful suction-irrigation pump;
- the patient should be placed in a standard supine position (5, 7);
- considering the positional changes, with both arms extended to allow for a possible laparotomy to be carried out and the chest prepared for an eventual thoracotomy (4,11);
- the insufflation pressure should be a maximum 14 mm Hg, usually 12 mm Hg; some authors recommend an

Table 5. Original articles about laparoscopy in BAT

Author	No of cases	TL	Overlooked injuries	Conversions	Complications	SBI
Taner (12)	28	0	0	11	0	0
Nicolau (13)	28	3	0	0	0	1
Meyer (14)	20	8	0	6	0	2
Chelly (15)	7	0	0	2	0	1
Choi (16)	52	49	0	9	3/78	32

Table 6. *Laparoscopic approach of SBI in BAT*

Author	No of cases	TL	Overlooked injuries	Conversions	Complications	SBI
Mitsuhide (17)	21	0	0	7	0	7
Mathonet (18)	23	5	0	10	0	15
Omori* (19)	22	11	0	0	1/11	11
Sinha* (20)	24	5	0	0	1/25	5

* laparoscopically assisted

initial pressure of 8 mm Hg until the diaphragm is inspected, and, if there are no lesions, an increase in intra-abdominal pressure is recommended (7, 13);

Initially, the surgeon and the assistant maneuvering the camera are positioned on the right hand side of the patient; later on the surgeon can stand on the left side. The capnoperitoneum is generated using the open or closed techniques. The Veress needle is introduced through a small para-umbilical incision or inferior to the left costal margin, on mid-clavicular line. With the open technique (open laparoscopy), a standard Hasson trocar is introduced through a vertical or transverse supraumbilical incision (4,13,19). It is recommended to use a 30° telescope that has a wide view. The patient is tilted in a 15-20° anti-Trendelenburg position and the left diaphragm is the first to be inspected, followed by inspection of the spleen, liver, right hemi-diaphragm, anterior stomach, transverse colon, and greater omentum. If a diaphragmatic lesion is spotted, the gas insufflation should be discontinued and a chest tube is placed (7).

In case of screening laparoscopy, the operation is confined to visual exploration followed by either exploratory laparotomy (presence of hemoperitoneum, intestinal content, visceral injuries) or medical observation (no injuries, no intraperitoneal pathological contents). However, experienced surgeons place one, or more often, two working trocars for atraumatic graspers and a suction-irrigation device. The trocars can be placed depending upon the site of injury: adjacent to the umbilicus on mid-clavicular lines on both sides, or on the midline, at mid xipho-umbilical line and mid pubo-umbilical line, respectively (11,13,15,16,42). If upon inspection of the peritoneal cavity, intestinal content or blood is found, the surgeon suctions the fluids. Suctioning the clots requires skill and patience. Sustaining the liver with a grasper or suction canula, the surgeon exposes and explores the visceral side of the liver, the gallbladder, the gastric antrum, and the duodenal bulb.

By placing the patient in a Trendelenburg position the surgeon is allowed to examine the Douglas pouch, the sigmoid colon, the rectum, and female internal genitalia. The most delicate part of the operation is considered to be the exploration of the jejunum and ileum. The surgeon begins exploring the bowel mesentery from the angle of Treitz by uncoiling a loop of bowel, 20 cm at a time, and examining it on both sides, with two atraumatic graspers (8). For less experienced surgeons, some authors suggested lengthening the supraumbilical incision (4-6 cm, vertically or horizontally),

identifying, eviscerating, and exploring the small bowel outside (4,19, 20). Prior to unwinding the bowel loops, the transverse colon and the greater omentum should be pushed cranially as much as possible. For a better exploration of the left and sigmoid colon, the operating table should be rotated towards the right. The rotation of the operating table towards the left with the surgeon standing on the patient's left side is preferred for the examination of the terminal ileum, cecum and right colon. Skilled surgeons can explore the pancreas and duodenum through the gastrocolic ligament and retracting downwards the hepatic flexure of the colon (5,14,16).

If the exploration of the peritoneal cavity is not significant for injuries mandating a therapeutic laparoscopy or laparotomy, after peritoneal lavage, placing a drainage tube next to the lesion or in Douglas pouch for a period of 24 to 48 hours is recommended (13,14). Conversion to exploratory laparotomy is required in the following cases: lesions cannot be identified, tight adhesions, obesity, inexperienced surgical team, uncertainty at diagnosis, severe hemoperitoneum, alteration of hemodynamic and respiratory status, and difficult visualization (4,8,12,13).

Therapeutic laparoscopy

Within the articles evaluating the role of laparoscopy in BAT, therapeutic laparoscopy represents a stage retained for selected and suitable cases in experienced and well-equipped medical centers (2,4,5,9,10). The extent of the injuries, the patient's general state, the surgeon's expertise in trauma care, and the surgeon's experience in laparoscopy, establish the crucial elements for laparoscopic approach of traumatic injuries (10, 65). The laparoscopic interventions can be entirely laparoscopically, laparoscopy-assisted or hand-assisted (16).

The aforementioned surgical interventions include:

- electrical hemostasis, use of argon beam coagulator for superficial (grade I/II) hepatic and splenic injuries, chemical hemostasis (13,14,22);
- hemostasis for mesentery and omental tears, by electrical coagulation, suture and clips (14, 17);
- phrenorrhaphy, gastrorrhaphy, enterorrhaphy, colorrhaphy, cystorrhaphy (16,18,23,29,30,42)
- laparoscopic or laparoscopy-assisted segmental enterectomy, Hartmann resection (16,18,20, 30)
- elective (when clotting does not occur, failed angio-embolization) or emergency laparoscopic or hand-assisted splenectomy (16,21,36,38);

- laparoscopic cholecystectomy for post-traumatic gall-bladder injuries (32-35);
- distal pancreatectomy, peripancreatic drainage (16,39,40).

Supportive laparoscopic interventions in patients with BAT include: feeding jejunostomy, temporary loop ileostomy for colo-rectal injuries, placing a catheter for peritoneal dialysis (11,57, 58). Therapeutic laparoscopy is indicated for approaching certain post-traumatic complications: diaphragmatic hernias (48,49,50), drainage of bilio-hematic collections following non-operative managed liver injuries (27,28), splenic cysts (52,53) post-traumatic acute cholecystitis (65).

Indications and contraindications

DL is employed once a thorough medical examination is performed, along with diagnostic peritoneal lavage, US, and/or CT. Indications are listed in Table 7. The contraindications are presented in Table 8. Hemodynamic instability is comprised of a systolic blood pressure < 90mmHg, heart rate < 110 ppm, and max. 2000 ml cristalloid solution for resuscitation (10,13, 16).

Discussion

Since abdominal trauma in Europe has a predominance of the blunt element compared to the United States, where laparoscopy is the sine qua non of PAT management protocol, this article reviews the role of laparoscopy only in BAT (8). The authors were struck by the small number of published articles, hence of evaluated cases, and by the lack of randomized studies and the small number of prospective ones. Since in 1999 a metanalysis evaluating the role of laparoscopy in abdominal trauma was published, we chose to study the articles published starting with 2000 (66). The role of laparoscopy, especially in BAT, has tapered off due to many factors, including the absence of complex multicenter randomized studies, the limited laparoscopic experience of trauma and general surgeons, the lack of standardized protocols, the legal complications, and the refinement of other diagnostic tools (CT, US, angiography, etc.) (2,9,69,70).

The main limitations attributed to laparoscopy were the lack of adequate equipment and trained medical personnel, the issue of general anesthesia, the fact that it is invasive, expensive, and does not allow a proper visualization of hollow organ injuries, particularly SBI, requires a longer operative time, and has specific complications (4-6,11, 66,71). Some of these limitations are now demoted.

Performing emergency laparoscopy as a routine procedure requires a specific equipment for the OR and the critical care team, highly trained surgeons in both trauma and laparoscopic surgery, qualified OR nurses available 24 hrs a day – things not readily available in all emergency hospitals. Compared to CT or US, laparoscopy is more invasive. A laparotomy requires general anesthesia as well but it is far more invasive than laparoscopy.

In the early '90s two articles were published analyzing the incidence of missed injuries by laparoscopy in BAT: 22%

Table 7. Indications for laparoscopy

Indications	References
Diagnosis of active bleeding or complete hemostasis in case of solid viscus injury (liver, spleen), especially when managed non-operatively;	8,13,14,15
Possible diaphragmatic injuries	2,5,11,63
Possible hollow organ injury and/or mesenteric injuries especially in multiple trauma patients with irrelevant clinical exam and indirect CT signs (most often free fluid in the peritoneal cavity without solid organ injury)	16,17,18, 29,30,66
Unfavorable progress of patients with BAT, with inconclusive imaging results which were managed non-operatively and with possible phrenic injury, peritoneal abscess, active bleeding, acute post-traumatic cholecystitis, mesenteric ischemia, etc.	59,65,67
Major differences between clinical exam and imaging results, or both, which are inconclusive in multiple trauma patients prepped for general anesthesia for an extra-abdominal surgical intervention	31
Temporary inability to perform a CT scan or even an US, but having the possibility to carry out a diagnostic laparoscopy; when dealing with a positive diagnostic peritoneal lavage or US, diagnostic laparoscopy may prevent a futile laparotomy	12, 13
Post-traumatic complications: diaphragmatic hernias, bilio-hematic perihepatic collections, hernias, ureteral injuries, etc.	27, 28, 44, 54 63

and 45% respectively (72,73). Despite the significant incidence, these missed injuries did not elude or delay exploratory laparotomy (2). Leppaniemi and Elliott (71) and Villavicencio and Aucar (66), both showed in their articles that the overall incidence of overlooked injuries in laparoscopy is around 1%. In the reviewed articles there were no overlooked visceral injuries, a fact justified by the improved quality of laparoscopic image, improved surgical equipment and perfected training of general and trauma surgeons in laparoscopy (11,16,69). Diagnostic laparoscopy allows identification of SBI or active bleeding from solid organ and mesentery lesions, including patients with non-operative management (5,6,16). Another disadvantage is that of operative time, although in the published studies it ranged between an acceptable 28 to 55 min (12-16). The postoperative complications did not exceed 1% in all meta-analysis from the 1990s (66,71). In all reviewed articles, the incidence of postoperative complications was between 0-6.3%, with no deaths associated to laparoscopy (14-18). With exploratory laparotomies, early postoperative complications reach an average incidence of 12-40%, late postoperative complications are 2-5%, and are associated with a death rate of 0-5% (16). The most common complications include pneumothorax, iatrogenic, visceral injuries, and extraperitoneal insufflation (4,8,13). There were no cases of gas embolization, not even in cases with large vessel injury

Table 8. Contraindications for laparoscopy

Contraindications	References
Hemodynamic instability, multiple injuries, significant bleeding, immediate life-threatening injuries	4,6-8, 11,12-16
Severe head trauma (GCS 11) without ICP* monitoring	6,8,11,13
Severe chest trauma with impaired respiratory status and/or severe myocardial contusion	11,13,68
Decompensated previous cardiopulmonary and hepatic diseases	11,68
Difficult access in the peritoneal cavity: postoperative adhesions, intestinal distension, pregnancy	68
Lack of experience and adequate equipment	8,13,16,68

*ICP: intracranial pressure

managed laparoscopically (11). The total cost of DL is smaller than for laparotomy (5,6,11). Laparoscopic screening is no longer imperative in BAT, but it remains an option in cases of PAT and thoracoabdominal injuries (5).

Diagnostic laparoscopy has unrivaled advantages such as direct and augmented image, direct and correct identification of lesions, assessment of free peritoneal fluid in terms of quantity and quality, autotransfusion, positive identification of diaphragmatic, hepatic, splenic, omental, and mesenteric injuries with an accuracy of 98-100% (5,8,13,16,66,71). It allows a precise indication for exploratory laparotomy, having a sensitivity of 94.1-100%, a specificity of 91-100% and an accuracy of 96-97.2% (66,71,72). The main advantages of laparoscopy include significant reduction of number of unnecessary laparotomies and of overlooked or underestimated injuries, a decrease of hospital stay, morbidity and overall costs (9,10,66). In recent study, the incidence of unnecessary laparotomies was set at 6% with 12% postoperative complications (74). In Villavicencio's meta-analysis it was shown that diagnostic laparoscopy determined a reduction of negative laparotomies by 34% and overall laparotomies by 63% (66). In our study there was a reduction of 36-78% of unnecessary laparotomies (12-16). Overlooked abdominal injuries or those with a delayed diagnosis are the third most missed traumatic injuries with an incidence of 3-65%, after extremity injuries and chest lesions and encompass small bowel, diaphragm, mesentery and pancreas lesions (11). Diagnostic laparoscopy has proved to be the most effective way to diagnose occult diaphragmatic injuries (2,4,55,62). Diagnostic laparoscopy outranks CT scan in suspected SBI when only indirect signs are relied upon (17,18,29,30). SBI after BAT are readily diagnosed compared to SBI within PAT (17). In highlighting intestinal injuries, CT scan has a sensitivity of 82-95% and a specificity of 98% (58). The articles reviewed comprised 78 cases of SBI approached laparoscopically and no overlooked injuries (12-20,29-31). Hospital length of stay was significantly reduced in patients with BAT and diagnostic laparoscopy (2.2-3 days) compared to those with unnecessary laparotomy (6-9 days) (5,12,13). There was also a reduction in hospital length of stay

in patients with therapeutic laparoscopy after BAT only compared to those that underwent therapeutic laparotomy (13,14). Indications of laparoscopic use in BAT presented however have a low grade of recommendation. The constant improvement of laparoscopic view, laparoscopic instruments, digital simulators, and further various improvements in laparoscopy will result in the near future in a less invasive and more effective approach of abdominal trauma (5, 11). When it comes to deciding between clinical, biological monitoring (repeated clinical exams, US, CT) and laparotomy in a limited number of cases with irrelevant imaging results and inadequacy between clinical status and imaging results, diagnostic laparoscopy is a good and efficient diagnostic modality. In specialized centers, experienced surgeons with vast work in laparoscopy and trauma are able to selectively approach cases of abdominal trauma with a therapeutic intent. In carefully selected cases with BAT, laparoscopy is still an effective and safe diagnostic and therapeutic tool, which can significantly reduce the number of unnecessary laparotomies and bears the hallmark advantages of minimally invasive surgery. Prospective multicenter studies are necessary to certify the role of laparoscopy in the near future.

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