THE ROLE OF LAPAROSCOPY IN THE DIAGNOSIS AND TREATMENT OF ABDOMINAL TRAUMA

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ABSTRACT:

Preventable laparotomy in patients with abdominal trauma who present with haemoperitoneum but with stable hemodynamics may be avoided if a diagnostic or therapeutic laparoscopy is performed. The assessment of a patient with abdominal trauma can be complicated by many factors, and the resultant inaccurate or delay in diagnosis has contributed to the unacceptable high mortality and morbidity for this type of injury. Diagnostic laparoscopy for the evaluation of injuries in patients with abdominal trauma has been shown to decrease the morbidity and mortality associated with mandatory laparotomy.The prognosis of abdominal trauma depends in most cases not only on the extent of existing injuries but also on prompt therapy. Thus, diagnostic measures have to clarify rapidly and accurately whether laparotomy has to be performed or not. Difficulties in decision for the surgeon arise especially in cases of abdominal trauma where diagnostic imaging (ultrasonography, CT scan) do not lead to clear-cut results. The use of laparoscopy as a diagnostic method dates back to the first decades of this century. Laparoscopic surgical techniques were first used by gynecologists and later, in 1989, Dubois performed the first cholecystectomy using a laparoscopic approach. Since then, in the space of a few years, there has been an overwhelming spread of video laparoscopic operating methods, extending the

therapeutic possibilities to gastroenterological surgery, as well as to thoracic, oncological, urological, and of course, gynecological surgery. The use of the laparoscope as a diagnostic method in abdominal trauma was proposed in the 70s by a number of authors, but only now, due to technological progress and the constant use of elective laparoscopic surgery, have surgeons been able to use this method for the diagnosis and treatment of patients with blunt or penetrating abdominal trauma. Rather than open laparotomy, laparoscopy can be used safely and effectively for the diagnosis and treatment of traumatic abdominal injuries. The following study was undertaken to find out the role of minimal invasive surgery in the diagnosis and management of abdominal trauma.

KEY WORDS:

Laparoscopic surgery, laparotomy, abdominal trauma, abdominal injuries, diagnostic laparoscopy, therapeutic laparoscopy

INTRODUCTION:

Minimally invasive surgical techniques have become increasingly utilized in all areas of surgery. Current use of laparoscopy in the evaluation and management of trauma patients has been a natural extension of this trend. Several studies [1] have analyzed various aspects of its application to the trauma patient. Although utilized for both blunt and

penetrating injuries, laparoscopy has gained the most widespread acceptance as a useful tool in the management of patients with penetrating abdominal injuries. Its ability to accurately determine anterior peritoneal penetration from stab and gunshot wounds has been proven. Others [2] have expanded its role beyond simply a screening tool for injury, to its current use in some centers as a diagnostic and therapeutic modality.Unnecessary abdominal explorations in severely injured patients can be reduced by employing emergent or urgent laparoscopy in blunt abdominal trauma and the obscured, acute abdominal cases. Today, the number of motor vehicle accidents (MVA) and other causes of abdominal trauma are high. If these patients present with hemoperitoneum with hemodynamic instability, the management is emergency exploratory laparotomy to check the bleeding. If, on the other hand, the patient is hemodynamically stable, the management is controversial. Such patients usually undergo emergency exploratory laparotomy, and in 15-30% of the cases the operation is unnecessary, as there is spontaneous homeostasis of the lesion producing the hemoperitoneum [3]. Another option with hemodynamically stable patients is to evaluate the lesion using computerized axial tomography (CAT) and undertake conservative management, primarily in cases where the lesion is hepatic[4]. This mode

of treatment requires a prolonged ICU stay, serial CAT scans, a long hospital stay, blood transfusion, and occasionally a delay in diagnosing abdominal lesions that may require laparotomy for treatment (hollow organ injury, bile leaks, pancreatic lesion, persistent bleeding, etc.) [2] The aim of this review paper is to present the value of diagnostic/therapeutic laparoscopy in abdominal trauma patients presenting with hemoperitoneum but having stable hemodynamic constants.

AIMS:

The purpose of this study is to evaluate the role of emergency laparoscopy as a diagnostic

and potentially therapeutic modality in abdominal trauma.

1. Method of patient selection
2. Operative technique
3. Operating time.
4. Intra-operative and postoperative complications.
5. Rate of Negative Laparotomy
6. Postoperative morbidity.
7. Hospital stay.
8. Cost effectiveness
9. Quality of life analyses
10. Late complications

MATERIALS AND METHODS:

A literature search was performed using search engine Google, HighWire Press & Online Springer Library facility available at Laparoscopy Hospital. The following search terms were used: “Laparoscopic in Abdominal Trauma, Negative Laparotomy, abdominal trauma, and abdominal injuries ". Selected papers were screened for further references, operative procedure

were selected only if they are universally accepted procedures and the institution where the study was done is specialized institution for laparoscopic surgery.

ABDOMINAL TRAUMA:

Trauma is the leading cause of death between the ages of 1 and 44 years. In all age groups, it is surpassed only by cancer and atherosclerosis in mortality [5]. The evaluation and treatment of abdominal injuries are critical components in the management of severely injured trauma patients. Because missed intra-abdominal injuries are a frequent cause of preventable trauma deaths, a high index of suspicion is warranted.

Multiple factors, including the mechanism of injury, the body region injured, the patient's hemodynamic and neurological status, associated injuries, and institutional resources influence the diagnostic approach and the outcome of abdominal injures.

Abdominal trauma is classified into two classes:

1) Blunt abdominal trauma (BAT)

2) Penetrating abdominal trauma which can be further classified as :

   a) Low-energy penetrating wounds

   b) High-energy penetrating wounds

MECHANISM OF INJURY:

BLUNT TRAUMA

The etiology of blunt abdominal trauma (BAT) is dependent on the environment of the receiving institution. The most common cause of BAT in metropolitan trauma centers is the motor vehicle collision (MVC), responsible for 45% to 50% of BATs. Assaults, falls, automobile–pedestrian accidents and work-related injuries are also common [6]. Abdominal injuries in blunt trauma result from compression, crushing, shearing, or deceleration mechanisms. Fortunately, the incidence of BAT requiring laparotomy is only 6%. The most frequently injured organs are the spleen (40% to 55%), the liver (35% to 45%), and the retroperitoneum (15%) [5].

PENETRATING TRAUMA

Gunshot wounds are the most common cause (64%) of penetrating abdominal trauma, followed by stab wounds (31%) and shotgun wounds (5%) [6]. Injury patterns differ depending on the weapon. Stab wounds are generally less destructive and have a lower degree of morbidity and mortality than gunshot wounds and shotgun blasts. The most commonly injured organs are the liver (40%), small bowel (30%), diaphragm (20%), and colon (15%) [5]. Gunshot wounds and other projectiles have a higher degree of energy and produce fragmentation and cavitations, resulting in greater morbidity [7]. These mechanisms result in multiple intra-abdominal injuries of the small bowel (50%), colon (40%), liver (30%), and abdominal vascular structures (25%) [5].Consequently, exploratory laparotomy traditionally has been warranted for gunshot wounds between the nipple line and the inguinal crease.

DIAGNOSTIC MODALITIES

PHYSICALEXAMINATION

BLUNT TRAUMA

Although the physical examination is the first step in evaluating the need for exploratory laparotomy, it has questionable validity in BAT [8]. The initial examination is often unreliable when the effects of alcohol, illicit drugs, analgesics or narcotics, or a diminished level of consciousness are present. The initial abdominal examination results in a 16% false-positive rate, a 20% false-negative rate, a positive predictive value of 29% to 48%, and a negative predictive value of 50% to 74% in determining the need for laparotomy [9]

PENETRATING TRAUMA

The physical examination is a more reliable indicator for laparotomy in penetrating trauma. In a prospective study, Quiroz et al identified two thirds of patients requiring laparotomy on initial physical examination. The remaining patients who required laparotomy developed physical findings within 10 hours of injury. [10] In the trauma patient with a stab wound, local wound exploration is a valuable diagnostic aid. Its utility is dependent on the wound's mechanism and location. Stab wounds to the anterior abdomen (anterior costal margins to inguinal creases,

between the anterior axillary lines) are a clear indication for local wound exploration, because many do not penetrate the peritoneum. Exploration requires aseptic technique and local anesthesia. The wound is enlarged as necessary so that the posterior fascia may be evaluated. If penetration occurs or is inconclusive, the wound is considered intraperitoneal. These wounds must be evaluated further by diagnostic peritoneal lavage (DPL) or laparotomy. Laparoscopy may play a vital role in diagnosing if the peritoneal cavity has been breached and if there are any intraabdominal injuries.

RADIOGRAPHY

BLUNT TRAUMA

The chest radiograph is useful in the evaluation of BAT for several reasons [11]. First, it identifies the presence of low rib fractures. This should heighten the examiner's suspicion for abdominal injuries and mandate further evaluation with an abdomen and pelvis CT. Pelvic fractures should raise the possibility of intra-abdominal injuries, and thus warrant further evaluation with an abdominal and pelvic CT scan [12].

PENETRATING TRAUMA

Plain abdominal x-ray in penetrating trauma allows one to account for bullets, shrapnel, and foreign bodies. If all foreign bodies are not accounted for, one must consider the

possibility that it is intra-luminal or intravascular. Intravascular foreign bodies are a potential source of emboli, and thus all intraperitoneal foreign bodies should be accounted for at exploration.

FOCUSED ASSESSMENT WITH SONOGRAPHY FOR TRAUMA

The focused assessment with sonography for trauma (FAST) examination is an important tool in the evaluation of abdominal trauma. Its portability, speed, noninvasiveness, and reproducibility make it an ideal diagnostic study. It has some limitations, in its dependency on free intraperitoneal fluid for a positive study. Thus, hollow visceral and retroperitoneal injuries are not detected reliably by the FAST exam [13].Thus recent studies have questioned its reliability in

the evaluation of BAT. Stengel et al performed a meta-analysis of 30 prospective trials evaluating FAST for BAT. They concluded that the FAST exam has an unacceptably low sensitivity for the detection of intraperitoneal fluid and organ injuries. They recommend that additional diagnostic studies be undertaken in patients with clinically suspected BAT regardless of the FAST results. [14]

DIAGNOSTIC PERITONEAL LAVAGE

BLUNT TRAUMA

Root et al introduced the Diagnostic Peritoneal Lavage, and inexpensive diagnostic test for the detection of intraperitoneal hemorrhage following abdominal trauma. Diagnostic peritoneal lavage is now used much less frequently in the immediate evaluation of trauma patients. However, it has the advantage of being a bedside procedure that can give quick and accurate information about the presence of blood in the peritoneal cavity Disadvantages include the DPL's invasiveness, risk of complications over noninvasive diagnostic measures, inability to detect retroperitoneal injuries, high rate of nontherapeutic laparotomies, and low specificity. In the hemodynamically unstable patient, a positive DPL indicates the need for an immediate laparotomy. In the hemodynamically stable patient, however, the DPL criteria are too sensitive and nonspecific. As such, a positive DPL based on aspiration of gross blood or red blood cell (RBC) count does not mandate emergency laparotomy in this patient population. [15]. An abdomen and pelvis CT scan will increase the specificity for surgical injury.

PENETRATING TRAUMA

The use of DPL in stab wounds is more complicated. Following local wound exploration, the DPL indices considered positive require modification. The RBC threshold indicating the need for Laparotomy is lowered to 10,000/mm^3 or 1000/mm^3, but the lower the threshold, the higher the false-positive rate. Using a higher threshold will increase the number of missed injuries. The remaining DPL criteria are unchanged.

COMPUTED TOMOGRAPHY

BLUNT TRAUMA

The abdomen and pelvis CT is the mainstay of diagnosis for abdominal injury in the hemodynamically stable patient. Sensitivity rates between 92% and 97.6% and specificity rates as high as 98.7%. The CT provides useful information as to specific organ injuries, and it is superior in diagnosing retroperitoneal and pelvic injuries. The CT scan is inaccurate in identifying hollow visceral injuries. If suspected, the DPL may be a useful adjunct [16].

PENETRATING TRAUMA

CT has a limited role in the evaluation of penetrating abdominal trauma. Its main drawback is its lack of sensitivity in diagnosing mesenteric, hollow visceral and diaphragmatic injuries, all of which are common in penetrating trauma. [17].

LAPAROSCOPY IN TRAUMA

Laparoscopy was first used for a trauma patient in1956 by Lamy, who observed two cases of splenic injury. Since then, Gazzaniga et al. [3] noted that laparoscopy is useful for determining the need for laparotomy. In 1991, Berci et al. [18] reported that he had reduced the number of non-therapeutic laparotomies performed for hemoperitoneum by25% through the use of laparoscopy in 150 patients with blunt abdominal trauma. Sosa et al. [19] found laparoscopy to be 100% accurate in identifying peritoneal stab wounds. Livingston et al. [20] and Brandt et al. [21] considered laparoscopy of potential benefit for abdominal wounds of unclear trajectory, noting that only 30% to 40% of abdominal stab wounds require surgery. They emphasized the significance of diagnostic laparoscopy for abdominal trauma patients. In another study, laparoscopy had a diagnostic accuracy of 100%, and averted non-therapeutic laparotomy in 82% of the cases. Possible algorithms for use of laparoscopy in the trauma setting are presented in Figs.1 and 2. Laparoscopic evaluation of the abdominal cavity has been established as sensitive and specific in the trauma setting (sensitivity, 94%; specificity, 98%) [22]. Whereas, inspection of the abdominal cavity and solid viscera is relatively easy to perform, complete examination of the intestine presents a greater challenge, with a 9% to 18% missed injury rate per patient [23]. Careful and complete inspection of the bowel and its mesentery is essential if laparoscopic trauma examination is to be reliable [24]. It must be kept in mind; however, that it is easy to miss small bowel perforations and retroperitoneal injuries to the colon. Ivatury et al. reported that only20% of bowel injuries are identified specifically at the time of laparoscopic examination. Three studies, those of Brandt et al.[21], Rossi et al. [25], and Mazuski et al. [23], showed that45 of 109 patients had missed injuries, resulting in a 41%missed injury rate per patient. The key to success is an extremely disciplined

appraisal of the findings, and the surgeon should not hesitate to do an exploratory laparotomy if he or she is not 100% certain that there are no missed injuries.

Laparoscopic techniques are being used with greater frequency for the diagnosis and management of traumatic injuries [26]. Although laparoscopy is an operative intervention, it has a role in limiting the need for a full laparotomy in some patients with gunshot injury and stab wounds. The procedure allows examination of the anterior intra-abdominal structures in a minimally invasive fashion. It has a potential advantage over standard open laparotomy in that the incisions are smaller, allowing quicker recovery time, less pain, and shorter postoperative hospital stays [27]. The limitations are that the entire abdominal cavity, especially the retroperitoneum and posterior diaphragm, cannot be adequately visualized with the laparoscope and subtle injuries to the small and large bowel can easily be missed. In a retrospective, multicenter study from 3 institutions with expertise in laparoscopy for trauma, the records of 510 patients undergoing the procedure as part of the initial evaluation for penetrating abdominal trauma were reviewed [28].Of these, 194 were for gunshot wounds, and the remainders were stab wounds. Laparoscopy assisted in determining the absence of peritoneal penetration in 113 (58%) gunshot wounds. Explorations performed on the remaining 81 gunshot wounds with peritoneal penetration resulted in only 15 non-therapeutic explorations, the most frequent sites of injury being the diaphragm, liver, and spleen. At laparotomy, some patients were found to have bowel injuries and injuries to retroperitoneal structures that were missed during the initial laparoscopic portion of the exploration, which confirms that although laparoscopy is a valuable diagnostic tool to determine peritoneal or diaphragmatic penetration, it is not adequate to fully explore the intra abdominal organs after penetrating injury.

BLUNT TRAUMA

The utility of diagnostic laparoscopy in BAT is a developing field. When performed in carefully selected hemodynamically stable patients, laparoscopy is safe and technically feasible. Chol et al reported reduced negative and nontherapeutic laparotomy rates in this identified population. [29]

PENETRATING TRAUMA

Diagnostic laparoscopy for the evaluation of penetrating trauma is more defined. In thoraco-abdominal stab wounds, laparoscopy may aid in the diagnosis of diaphragmatic and other intra-abdominal injuries, thus avoiding nontherapeutic laparotomies[29]. Gunshot wounds to the anterior abdomen with

questionable tangential trajectory similarly may be assessed. Fabian et al while working at Memphis, Tennessee concluded that diagnostic laparoscopy is a safe, efficacious means of evaluating patients with equivocal peritoneal penetration. While the necessity of urgent explorative laparotomy as a standard procedure in the treatment of abdominal stab wounds is controversial. Many surgeons, especially in the United States, tend to follow a more conservative approach in uncomplicated cases, arguing that 30–50% of all stab wounds do not even perforate the peritoneum and another 20–40%cases with perforated peritoneum do not involve visceral injuries which require surgical interventions -resulting in non-therapeutic laparotomy rates of up to 70% [30]. Until the end of the 1980s most European surgeons recommended an exploratory laparotomy if local exploration could not determine the depth of the wound. The argument is that even if there are no clinical signs of intraabdominal injuries, the disadvantages associated with an unnecessary laparotomy are minor compared to the danger of peritonitis in cases of delayed diagnosis of intestinal perforation[31].An alternative to these extremes is laparoscopy which allows the inspection of the peritoneum for signs of perforation and furthermore, in selected cases, the treatment of intraabdominal injuries [32].The rate of nontherapeutic laparotomies, which are associated with a considerable morbidity, may thus be reduced, as well as the length of hospital stay and treatment costs [33].

The historical basis for non-operative management of gunshot injuries stems from early work in stab injury by Shaftan [34]. In a 1960 he reported patients with stab wounds to the anterior abdominal wall that were triaged according to the physical examination and basic diagnostic maneuvers such as nasogastric tube insertion, urinalysis, and plain radiographs. It was found that a normal abdominal examination, without associated evidence of hematuria, hematochezia, or free air in the abdomen, essentially excluded intra-abdominal injury that would necessitate immediate laparotomy. A later report by Nance et al [35] included more than 1,180 patients who either underwent mandatory exploration or a selective non-operative approach with observation. Of the 432 patients who had mandatory exploration, 53% were found to have absolutely no injuries (i.e., negative laparotomy), and 10% were found to have minor injuries that did not require surgical intervention (i.e., nontherapeutic laparotomy), which was in contrast to only a 10% negative and 3% non-therapeutic rate in the 126 patients treated with a selective non-operative approach. In addition, he found that the overall complication rate was higher in the mandatory laparotomy group (13.9%) compared with the selective non-operative group (6.3%). Most important, in the group that was observed without an operation, only 10(4%) of 266 patients required a delayed operation for progressing symptoms, with no deaths and only 1 wound infection complication. Several other groups have demonstrated low delayed laparotomy rates and low complication rates with non-operative management for stab wounds. In 1996, Leppaniemi and

Haapiainen [36] presented one of the few prospective randomized trials of non-operative management of stab wounds. They showed equivalent mortality with selective non-operative management compared with mandatory exploration (18% versus 19%; *P*=.26). In addition, they showed a decreased length of stay and overall cost reduction in patients treated by observation. Four (17%) patients originally randomized to observation required delayed exploration, with no deaths; 1 patient developed an incarcerated diaphragmatic hernia from a missed injury, and 1 patient's course was complicated by an empyema. For gunshot wounds, laparoscopy can be used to rule out peritoneal violation in selected cases when the clinical examination is equivocal. Sosa et al. [19] selected hemodynamically stable patients with wounds in which the path of the bullet appeared tangential to the peritoneal cavity. Ortega et al. [37] described the advantages of laparoscopy for abdominal stab wounds Laparoscopy avoids unnecessary laparotomy and prevents the risk of undiagnosed hollow viscous injury leading to delayed laparotomy for acute peritonitis. The average hospital stay for the group that underwent totally therapeutic laparoscopy (n = 43) was 8.9days, but the stay for the nontherapeutic (diagnostic) laparoscopy group (n = 13) was 2.2 days. These somewhat long stays were the result of other associated injuries such as extremity wounds in the majority of patients.

DISCUSSION

Current trends in all areas of surgery are towards minimal invasive techniques. Data shows that laparoscopy is a useful modality for evaluating and managing hemodynamically stable trauma patients with penetrating injuries. Increased use of laparoscopy in select patients with penetrating abdominal trauma will decrease the rate of negative and nontherapeutic laparotomies, thus lowering morbidity, decreasing length of hospitalization, and provide for more efficient utilization of available resources. As technology and expertise among surgeons continues to improve, more standard therapeutic interventions may be done laparoscopically in the future. Mandatory surgical exploration for gunshot wounds to the abdomen has been a surgical dictum for the greater part of this past century. Although non-operative management of blunt solid organ injuries and low-energy penetrating injuries such as stab wounds is well established, the same is not true for gunshot wounds. The vast majority of patients who sustain a gunshot injury to the abdomen require immediate laparotomy to control bleeding and contain contamination. Non-operative treatment of patients with a gunshot injury is gaining acceptance in only a highly selected subset of hemodynamically stable adult patients without peritonitis. Although the physical examination remains the cornerstone in the evaluation of patients with gunshot injury, other techniques such as computed tomography, diagnostic peritoneal lavage, and diagnostic laparoscopy allows accurate diagnosis of intra-abdominal injury. The ability to exclude internal organ

injury non-operatively avoids the potential complications of unnecessary laparotomy. Clinical data to support selective non-operative management of certain gunshot injuries to the abdomen are accumulating, but the approach has risks and requires careful collaborative management by emergency physicians and surgeons experienced in the care of penetrating injury. Sosa et al [19] reported 121 consecutive abdominal gunshot wounds managed with laparoscopy. Seventy-nine (65%) had negative laparoscopy, and these patients were managed without laparotomy. Another7.2% avoided nontherapeutic laparotomy.

It is very important to determine the presence, location, and severity of intraabdominal injury: to decide the surgical intervention; and to thoroughly evaluate intraabdominal organs for associated injuries in the trauma patient. For stab wounds, serial physical examination is supplemented by local wound exploration, diagnostic peritoneal lavage (DPL), abdominal US, abdominal CT, Magnetic resonance imaging (MRI), and in some cases, angiography to maximize the value of surgical intervention and to reduce negative and non-therapeutic laparotomy. Despite their many positive qualities, these diagnostic methods have some drawbacks. DPL is an invasive but sensitive procedure; it may result in a non-therapeutic laparotomy with its attendant morbidity. The use of CT is limited to the hemodynamically stable patient. There has been increasing interest in the use of abdominal US because it is portable, non-invasive, rapid, and easily repeatable. However, less accurate for diagnosis of diaphragmatic and hollow viscous. With experience in laparoscopic cholecystectomy and the advent of improved and readily accessible laparoscopic equipment and devices, laparoscopic surgery became widespread for intraabdominal operations, setting the sage for renewed interest in its applications for the diagnosis of traumatic abdominal injuries and examination of their therapeutic potential.

In the evaluation and management of the abdominal injury, current diagnostic methods have a defined sensitivity, specificity, and accuracy, but none of these represents a gold standard. Thus abdominal exploration by laparotomy should not be discarded as a worthy diagnostic and therapeutic procedure for patients with equivocal and unreliable findings. It is associated with complication rates as high as 40% including a 10% to40% negative laparotomy rate, a 20% morbidity rate, a 0% to 5% mortality rate, and a 3% long-term risk of bowel obstruction secondary to adhesions.

Laparoscopy has been reported infrequently as a therapeutic tool in selected trauma patients. Examples of therapeutic laparoscopy include repair of diaphragmatic lacerations with sutures, staples, or prosthetic mesh; suturing of gastrointestinal perforations; hemostasis of low-grade liver and splenic

lacerations; resection of small bowel and colon; cholecystectomy; splenectomy; and distal pancreatectomy [38]. Auto-transfusion of collected blood from the hemoperitoneum is another potential application [39].Fabian et al [40] in a large study of 182 trauma patients, reported one suture repair of diaphragmatic injury. Successful laparoscopic repair of small bowel, colon ,and rectal injuries, and laparoscopic repair of a small gastric stab wound using hernia stapler have been reported recently [41].For the repair of solid visceral injuries, there are three methods that merit investigation: the totally laparoscopic procedure, the laparoscopically assisted procedure, and hand assisted laparoscopic surgery (HALS). The argon beam coagulator, fibrin glue, topical haemostatic agent, and absorbable mesh may be beneficial for hepatic and splenic lacerations. Laparoscopic repair of bowel injuries can be performed using suture or staples. Primary suture repair of a small bowel injury would be amenable by a totally laparoscopic procedure. Using a porcine model, Pietrafitta et al. [42] and Soperet al. [43] described a technique for an intraperitoneal functional end-to-end anastomosis of the small intestine. Milsom and Bohm [44] modified these techniques and reported that their technique for intracorporeal intestinal anastomosis has been proved safe in dozens of animal and human procedures, but that it had some drawbacks. It requires a long operating time and needs two or three30-mm Endo-GIAs and a skin incision for specimen retrieval. Recently, animal research has assessed the potential for hand-assisted laparoscopic exploration to detect traumatic injuries. Asbun et al [1] reported that hand-assisted laparoscopic exploration is more accurate than laparoscopic exploration alone in detecting injuries (63% vs. 38%), but that it still resulted in an unacceptable rate of missed injuries. Hand-assisted laparoscopic surgery allows for the application of minimally invasive surgical techniques to complex intraabdominal operations, particularly when specimen removal is required. The rationale for this approach is that the hand offers the surgeon some advantage in terms of tactile feedback, exposure, retraction, and orientation, enabling the surgeon to perform with greater safety and efficiency. Most trauma surgeons consider omental herniation through an anterior abdominal stab wound an indication for laparotomy because frequently there are significant intraabdominal injuries. As an alternative to laparotomy, the herniated omentum was evaluated and managed, with laparoscopy performed through the abdominal stab wound or accessory trocar. If there are no significant injuries, the wound can be managed without further treatment [45]. Depending on the surgeon's preference, therapeutic laparoscopy can be continued. The complications of laparoscopy for trauma include not only the usual complications of anesthesia and laparoscopy, but also some that are unique to the trauma patient [46]. Fabian et al. [40] independently reported the development of tension pneumothorax in patients with diaphragmatic injury from positive-pressure pneumoperitoneum. If suspected, induction of pneumoperitoneum is stopped, and an immediate needle thoracocentesis is performed, followed by a tube thoracostomy if

needed. However, routine prophylactic tube thoracostomy is not indicated. The risks of gas embolism in patients with intraabdominal venous injuries, especially liver lacerations, are another problem. Among 133 laparoscopic examinations of trauma, Smith et al. [47] did encounter this complication in two patients with injuries of the inferior vena cava tamponaded by clot. This potential problem of laparoscopy has stimulated interest in ‘‘gasless’’ laparoscopy [48] based on expansion of the peritoneal cavity by mechanical retractors. In addition to averting the risks of tension pneumothorax and gas embolism, it facilitates the use of conventional instruments such as hemostats, needles, sutures, and electrocautery, resulting in significant cost savings. The major disadvantage of gasless laparoscopy, however, is the excessive cost of the powered mechanical arm and the poor exposure in the lateral gutters [49]. Less expensive apparatus to lift the abdominal wall is expected. The transperitoneal absorption of carbon dioxide may cause metabolic and hemodynamic changes such as acidosis, cardiac suppression, atelectasis, subcutaneous emphysema, and increased intracranial pressure, resulting in more profound consequences for the trauma patient [50].Joseph et al [51] demonstrated that carbon dioxide(CO_2) pneumoperitoneum causes significantly increased intracranial pressure in a porcine model of head injury. The results of this study led them to recommend the avoidance of CO_2 pneumoperitoneum for the evaluation of patients with head injuries. Undoubtedly, gasless laparoscopy could replace CO_2 pneumoperitoneum in these cases. Missed intra-abdominal injuries are among the most frequent causes of potentially preventable trauma deaths. The evaluation and management of abdominal trauma is dependant on multiple factors, including mechanism of injury, location of injury, hemodynamic status of the patient, neurological status of the patient, associated injuries, and institutional resources. Therefore careful selection, high index of suspicion, and a low threshold for laparotomy will provide the patient the benefits of minimal invasive surgery and reducing the rates and morbidity of unnecessary laparotomy.

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