

Laparoscopy for Penetrating Thoracoabdominal Trauma: Pitfalls and Promises

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ABSTRACT

Background: How should the stable patient with penetrating abdominal or lower chest trauma be evaluated? Evolving trends have recently included the use of diagnostic laparoscopy. In September 1995 we instituted a protocol of diagnostic laparoscopy to identify those patients who could safely avoid surgical intervention.

Design: Prospective case series.

Materials and Methods: Hemodynamically stable patients with penetrating injuries to the anterior abdomen and lower chest were prospectively evaluated by diagnostic laparoscopy, performed in the operating room under general anesthesia, and considered negative if no peritoneal violation or an isolated nonbleeding liver injury had occurred. If peritoneal violation, major organ injury or hematoma was noted, conversion to open celiotomy was undertaken.

Results: Seventy consecutive patients were evaluated over a two-year period. The average length of stay (LOS) following negative laparoscopy was 1.5 days, and for negative celiotomy 5.2 days. There were no missed intra-abdominal injuries following 30 negative laparoscopies, and 26 of 40 laparotomies were therapeutic. The technique also proved useful in evaluation of selected blunt and HIV+ trauma victims with unclear clinical presentations. However, while laparoscopy was accurate in assessing the abdomen following penetrating lower chest injuries, significant thoracic injuries were missed in 2 out of 11 patients who required subsequent return to OR for thoracotomy.

Conclusions: Laparoscopy has become a useful and accurate diagnostic tool in the evaluation of abdominal trauma. Nevertheless, laparoscopy still carries a 20% nontherapeutic laparotomy rate. Additionally, significant intrathoracic

injuries may be missed when laparoscopy is used as the primary technique to evaluate penetrating lower thoracic trauma.

Key Words: Laparoscopy, Penetrating trauma.

INTRODUCTION

How should the stable patient with penetrating abdominal or lower chest wall trauma be evaluated? Traditional diagnostic methods and liberal indications for surgery have resulted in negative laparotomy rates ranging from 12-40%.^{1,2} While negative laparotomy was previously accepted as the inevitable and innocuous result of this policy, recent reports by Renz and others²⁻⁴ have highlighted the 6-40% incidence of complications that accompany nontherapeutic abdominal exploration.

In view of these data, and dissatisfied with our own 33% negative laparotomy rate, prospective evaluation of the role of diagnostic laparoscopy in the evaluation of suspected penetrating abdominal injury was undertaken in September 1995 to identify those patients who could safely avoid surgical intervention, with the expectation that the rate of negative trauma celiotomy would markedly decrease.⁵⁻⁷ In this report we review our experience with 70 consecutive patients who underwent diagnostic laparoscopy, and discuss the benefits and pitfalls in diagnosis we encountered utilizing this technique.

MATERIALS AND METHODS

A prospective study of patients with penetrating injuries to the lower thorax and anterior abdomen admitted to the Bellevue Hospital Trauma and Shock Unit, a Level I trauma center in New York City, was performed between September 1995 through November 1997. Patients who were hemodynamically stable without obvious evidence of peritoneal penetration or free intra-abdominal air on upright chest radiograph were entered into the protocol. In light of evidence that CO₂ pneumoperitoneum may result in an increase in intracranial pressure, patients with known or suspected central nervous system injuries were initially excluded from the protocol.⁸⁻¹⁰ However, the use of diagnostic laparoscopy may be appropriate in head-injured patients when intracranial pressure monitors are in place.

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After initial evaluation in the emergency room, informed consent was obtained and the patient was transferred to the operating room. General endotracheal anesthesia was induced, orogastric tube and Foley catheter inserted, and open laparoscopy performed with the Hasson trocar positioned infraumbilically. After insufflation with carbon dioxide gas to 15 mm Hg, a 10 mm laparoscope with attached video camera was inserted into the peritoneal cavity, and exploration performed. In patients with thoracoabdominal injuries and suspected diaphragmatic tears, a low pressure pneumoperitoneum of 8-10 mm Hg was created, the diaphragms visualized, and if no diaphragmatic injuries were present, the pneumoperitoneum was raised to 15 mm Hg. Routine thoracostomy tubes were not placed prophylactically in light of Zargut's reported 1% pneumothorax rate¹¹ following carbon dioxide insufflation (5 of 510 patients); rather, the anesthesia and surgical teams were alerted to the possible development of a tension pneumothorax in patients at risk for diaphragmatic injury. If no peritoneal violation was noted, or an isolated non-bleeding injury to the liver was present beneath the site of peritoneal penetration, the procedure was terminated, and the patient subsequently discharged from the hospital. If peritoneal violation, major organ injury or hematoma were noted, the procedure was converted to open celiotomy.

During this period we did not utilize the technique of "gasless laparoscopy," or perform "minilaparoscopy" in the emergency department with local anesthesia utilizing 3-5 mm videoscopes.

Trauma service records were reviewed for the two years which preceded this study (1993 – 1994); the overall negative exploration rate for all patients with penetrating abdominal trauma during that time period was 33%.

RESULTS

Seventy patients were enrolled over a 24-month period. The ages ranged from 18 – 64 with a mean of 30.1. Sixty-four (91%) patients were male and six (9%) female. Forty-

four patients (63%) suffered stab wounds to the anterior abdomen, eleven (16%) stab wounds to the left chest with suspicion of intra-abdominal injury, 13 (19%) with abdominal gunshot wounds. Two additional patients (3%) involved in motor-vehicle accidents were evaluated laparoscopically after indeterminate computed tomographic (CT) scans.

Operative Findings: The mean operative time for laparoscopy was 16 minutes (range: 3 – 60). The mean time for negative laparoscopy was 23 minutes, and 10.8 minutes for laparoscopy with positive findings. Forty-one (59%) procedures met criteria for positive laparoscopy: thirty-nine were converted to celiotomy and two additional nonbleeding liver injuries were treated nonoperatively. Twenty-five (65%) of the 39 laparotomies were considered therapeutic by the operating surgeon. Among the 14 nontherapeutic laparotomies, ten were performed in patients with peritoneal penetration visualized on laparoscopy but found to have no intraperitoneal injury at laparotomy, three revealed only minor nonbleeding liver injuries early in our study that the individual attending surgeon was unwilling to treat nonoperatively, and one was performed for free blood secondary to a minor omental laceration.

Length of Stay: In patients without associated injuries, the mean length of stay following negative laparoscopy was 1.5 days in 21 patients (range: 1 – 4; the single 4-day stay was due to social service issues), compared to 5.2 days (range: 3 – 8) for 12 negative explorations following positive laparoscopy.

Morbidity: There were no anesthetic complications in the study group, and no tension pneumothoraces or air emboli occurred. One small bowel injury resulted from insertion of the Hasson trocar, and was repaired primarily in a patient during laparotomy for a thoracoabdominal gunshot wound with liver, adrenal and diaphragmatic injuries. There were no deaths.

Missed Injuries: No intra-abdominal injuries were missed in the negative laparoscopy group (**Table 1**).

Site of injury	# patients	negative laparoscopy	positive laparoscopy	missed injury: return to OR
lower chest	11	10	1	2
abdomen	59	21	38	0

However, two of ten patients (20%) who underwent negative laparoscopy for lower left chest stab wounds required urgent return to surgery from the recovery room for missed ongoing hemothoraces. One was a 23-year-old female stabbed in the left anterior axillary line at the 7th intercostal space. A closed tube thoracostomy was performed for a nonbleeding pneumothorax upon initial presentation to the emergency room, and she was transferred to the operating room, where laparoscopy revealed no evidence of peritoneal penetration. Soon after arrival in the recovery room she drained 750 milliliters of blood from her chest tube and became hypotensive. She was returned to the operating room, where thoracotomy revealed an actively bleeding injury to the lingula which was successfully controlled by stapled wedge resection. The second patient also required a left thoracotomy to oversee bleeding from the lung parenchyma.

DISCUSSION

The optimal management of the asymptomatic patient with penetrating thoracoabdominal trauma has yet to be determined. Prior to September 1995, the criteria for mandatory laparotomy at our institution were broad and included all anterior abdominal gunshot injuries, and stab wounds to the anterior abdomen with posterior fascial penetration demonstrated by local wound exploration. This policy resulted in a 33% overall negative laparotomy rate. Recent reports have emphasized the complication rate following negative laparotomy for trauma, ranging from a six percent³ to 20% incidence in Renz and Feliciano's series of 81 patients with penetrating abdominal trauma without associated injuries,⁴ and 22% in Sosa's recent comparison of mandatory laparotomy and diagnostic laparoscopy for asymptomatic abdominal gunshot wounds.¹ Leppaniemi et al. from Finland² reported their 24-year experience of a 40% negative laparotomy and 21% complication rate in 457 patients following mandatory laparotomy for penetrating truncal trauma. While many of the complications following negative laparotomy in these four reports were minor, they did result in prolongation of the mean hospital stay.

Sosa et al.¹ prospectively studied 85 patients with asymptomatic abdominal gunshot wounds by diagnostic laparoscopy, and compared them to the preceding four-year period when mandatory laparotomy was performed in a similar group of 817 patients. He was able to document a drop in the negative laparotomy rate from 12.4% to 4.7% when routine diagnostic laparoscopy was instituted. Additionally, there was a significant decline in average length of stay from 5.1 to 1.4 days, with no missed intraperitoneal injuries and only one significant complication (urinary retention) following negative laparoscopy.

The largest experience to date with the use of diagnostic laparoscopy is a retrospective multicenter study of 510

patients¹¹ with penetrating abdominal trauma. In this series, 54.3% of exams revealed either nonpenetration or nonsignificant injuries, and the mean hospital stay was 1.7 days in the absence of associated injuries. There were no significant missed injuries following negative laparoscopy. Laparotomy was considered therapeutic in 155 of the 213 patients (73%) who underwent formal abdominal exploration. Diaphragmatic injuries were present in 40% of penetrating thoracoabdominal injuries. Of interest is an additional group of 26 patients who underwent therapeutic laparoscopy, including repair of diaphragmatic and anterior gastric lacerations, and control of hepatic bleeding. While it is not clear from this paper whether laparoscopy resulted in a reduction in the rate of negative laparotomy (which was 25% overall in this combined series), it does indicate that laparoscopy can safely and reliably select those patients without intraperitoneal injury who can be spared a negative laparotomy.

In view of these reports, and dissatisfied with our own negative laparotomy rate, prospective evaluation of diagnostic laparoscopy was undertaken with the expectation that insignificant injuries could be reliably identified, thus reducing both the incidence of negative celiotomy and hospital length of stay. In the 70 consecutive patients who underwent diagnostic laparoscopy, the negative laparotomy rate was 20%, and if the trivial liver injuries explored early in our experience are excluded, the rate drops to 16%. This is comparable to the negative laparotomy rates of 11-20% following laparoscopy recently reported by other authors.^{7,11-14} Overall, the negative exploration rate for all patients with penetrating abdominal trauma treated during this time period at our institution fell from 33% to 20%. While a significant decrease in our negative laparotomy rate occurred, it is still not negligible, and this failure to eliminate nontherapeutic laparotomy in one-fifth of the cases of penetrating trauma is the "Achilles' heel" of diagnostic laparoscopy as currently practiced. As our ability to laparoscopically explore the peritoneal cavity, reliably examine the large and small bowel, and perform laparoscopic repair of selected injuries improves,^{11,15-17} the negative laparotomy rate should continue to decline and can be expected to approach five percent.

Since Bellevue Hospital charges a fixed comprehensive daily rate, a true cost analysis could not be made, leaving the length of stay as the only valid index of comparison; during the study period it was 5.2 days following negative laparotomy as compared to 1.5 days after negative laparoscopy. At current charges of \$1,000 per day, a 3.7 day decrease in length of stay represents a \$3,700 reduction in cost per patient, which translates into an overall savings of \$77,700 for the 21 patients who underwent negative laparoscopy and did not require additional hospitalization for associated injuries.

While primarily used to evaluate penetrating injuries, laparoscopy also proved to be a useful tool in selected blunt trauma patients with benign clinical exams and indeterminate radiologic studies. One patient had a minimal amount of free fluid in the pelvis on computed tomography (CT); laparoscopy revealed turbid fluid, and a perforation of the antimesenteric border of the proximal jejunum was found and repaired at laparotomy. The second patient was a pedestrian struck by a taxi on the right flank and hip; she was hemodynamically stable and complained only of right hip pain upon evaluation in the Emergency Room. She had undergone cholecystectomy ten years earlier via an upper midline incision. There was a question of bowel gas above the left hemidiaphragm on chest roentgenogram, and both CT scan and upper gastrointestinal series were equivocal regarding the presence of a diaphragmatic rupture. Laparoscopy revealed free blood in the peritoneal cavity, and a splenic laceration and intact left hemidiaphragm were found at exploration.

Another subgroup in whom diagnostic laparoscopy proved efficacious was in the evaluation of the trauma patient infected by the human immunodeficiency virus. Three HIV+ patients with abdominal stab wounds and equivocal physical exams underwent negative laparoscopy, sparing all three an unnecessary abdominal exploration.

However, we encountered a significant pitfall in our experience with 70 consecutive patients. Laparoscopy has been championed by some authors^{11,18,19} as a routine maneuver in the evaluation of penetrating lower chest injuries to detect clinically and radiologically occult diaphragmatic injuries. In this study, laparoscopy was selectively employed to evaluate those lower chest injuries felt to be at particular risk for intra-abdominal injuries, and one diaphragmatic injury was detected and repaired. However, two of the remaining ten patients with thoracoabdominal stab wounds who underwent negative diagnostic laparoscopy manifested ongoing thoracic blood loss that necessitated return to the operating room, reinduction of general anesthesia and thoracotomy for definitive control of pulmonary parenchymal bleeding. Clearly, routine diagnostic laparoscopy in these patients resulted in initial evaluation of the wrong body cavity, and lulled us into a false sense of security regarding the extent and severity of injury. Thus, in patients with penetrating thoracoabdominal trauma and negative diagnostic laparoscopy, we now believe that diagnostic thoracoscopy should be performed before the patient leaves the operating room. The applications of thoracoscopy in the trauma patient are expanding; this technique can be

used to detect and repair diaphragmatic injuries, evaluate the pericardium, and treat both ongoing and established hemothoraces.^{20,21}

CONCLUSIONS

This experience confirms that laparoscopy is a safe and accurate tool for identifying peritoneal penetration following penetrating abdominal trauma, and adoption of this technique resulted in significant decreases in both the rate of negative laparotomy, and the hospital length of stay following a negative evaluation. One drawback is that the rate of negative laparotomy, while reduced, remains in the range of 10-20% in our experience and recent comparable series.

Diagnostic laparoscopy reliably identifies those injuries to the liver that can be safely managed nonoperatively. It also proved useful in the evaluation of the HIV+ patient with equivocal findings on physical exam, and of stable patients with indeterminate or "soft" CT scan findings following blunt abdominal trauma. While other authors have demonstrated its sensitivity in the detection of diaphragmatic injuries, we urge caution in its use as the primary diagnostic study in penetrating thoracoabdominal trauma based on our experience with missed major intrathoracic injuries, and are currently investigating the complementary role of thoracoscopy in penetrating lower thoracic injuries.

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