



1)

A 26-year-old male presents to the emergency department 3 hours after sustaining a stab wound with a knife in an altercation. The patient's primary survey is significant for tachypnea (20 breaths per minute) and decreased breath sounds on the left. On exam, the patient has a wound in the left inferior costal margin just lateral to the mid-clavicular line with minimal bleeding. His abdominal exam is benign. A chest X-ray shows scant fluid in the left chest and a moderate pneumothorax. What is the best next step?

- A. Perform local wound exploration
- B. Place a chest tube in the left chest
- C. Proceed to CT scan
- D. Perform exploratory laparotomy

**The patient has sustained an injury to the thoracoabdominal region which is defined by the fourth intercostal space (nipple line) anteriorly and the tips of the scapulae (seventh intercostal space) posteriorly and the inferior costal margin inferiorly. Wounds in this general region pose significant threat, as injury to the chest, mediastinum, abdomen as well as diaphragm are all possible.**

2)

A chest tube is placed in the left chest with a rush of air and return of 150 ml of blood. The patient's breathing improves. Focused assessment with sonography for trauma (FAST) is performed and does not show intraabdominal fluid or pericardial fluid. The patient is hemodynamically stable with a benign abdominal exam. What would be the next best step to rule out diaphragm injury?

- A. AP and lateral chest X-ray
- B. Chest and abdominal CT scan
- C. Diagnostic peritoneal lavage
- D. Diagnostic laparoscopy

**Given the location of this left thoracoabdominal stab wound, a diaphragmatic injury must be ruled out.<sup>1</sup> Imaging through x-ray and CT scan can be inconclusive. Although imaging can be helpful, a negative film or scan does not definitively rule out intrabdominal injury in this setting. Laparoscopy has a sensitivity of 88 percent and a specificity approaching 100 percent in the diagnosis of diaphragmatic injury.<sup>2</sup> In one retrospective review of 119 patients with left-sided penetrating thoracoabdominal trauma, 31 percent of patients were found to have diaphragmatic injury on laparoscopy without abdominal tenderness. A normal chest radiograph was seen in 40 percent.<sup>1</sup> Patients selected for diagnostic laparoscopy should not have indications for immediate laparotomy, such as hemodynamic instability, diffuse peritonitis, evisceration, or evidence of end-organ injury (e.g. hematuria, bloody nasogastric tube output, etc.).<sup>2</sup> An additional advantage of performing diagnostic laparoscopy is that the procedure**



may be potentially therapeutic if a diaphragmatic injury is discovered. Diagnostic laparoscopy can also be utilized to rule out other intraabdominal injuries.

3)

The patient is brought to the operating room. The patient is placed supine, and a standard trauma prep with betadine wash from chin to thighs is performed as the patient is intubated. Where would you stand in relationship to the patient, and how would you place your ports for a diagnostic laparoscopy to evaluate for left diaphragmatic injury?

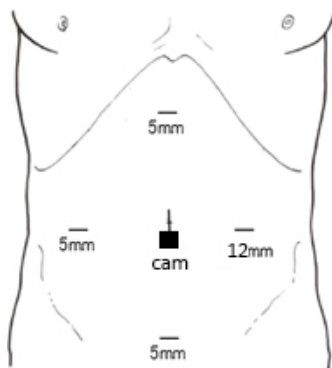
A. Standing on the left side of the patient, introducing a trocar through umbilicus with additional ports in the epigastrium and left upper quadrant

B. Standing on the right side of the patient, introducing a trocar through umbilicus with additional ports in the epigastrium and left upper quadrant

C. Standing on the right side of the patient, introducing a trocar through umbilicus with additional ports in the epigastrium and right upper quadrant

D. Standing on the left side of the patient, introducing a trocar through umbilicus with additional ports in the epigastrium and right upper quadrant

**The first port is best achieved at the umbilicus with an open technique. Though not contraindicated, needle insufflation is not recommended in trauma patients who may have a distended bowel. Pneumoperitoneum should be slowly and progressively established. Insufflation should be discontinued if the patient develops abrupt rise in airway pressures, hypotension, or tachycardia. Additional ports should then be placed in the left upper quadrant and epigastric region to explore the left diaphragm.<sup>3</sup> A possible port configuration is shown here.**



4)

Upon insufflation, the patient develops acutely increased peak airway pressures, hypotension, and oxygen desaturation. You discontinue insufflation. What is the most likely cause of the patient's decompensation?



- A. Tension pneumothorax
- B. Allergic reaction to medication
- C. Hemorrhagic shock
- D. Vasovagal reaction

Diagnostic laparoscopy-related complications are reported in up to 2.8 % of patients. The most common complication of laparoscopy in trauma is tension pneumothorax due to pneumoperitoneum in patients with unexpected diaphragmatic injuries. This condition can be easily treated with the suture of the diaphragmatic injury and placement of a thoracostomy tube. Other complications of laparoscopy for trauma include iatrogenic perforation of a hollow viscus, laceration of a solid organ, and vascular injuries during trocar insertion or abdominal exploration and bowel manipulation. Although rare, gas embolism in patients with intra-abdominal venous injuries, such as liver lacerations, may also occur. Transperitoneal absorption of carbon dioxide which may cause metabolic and hemodynamic changes such as acidosis, cardiac suppression, atelectasis, subcutaneous emphysema, and increased intracranial pressure may lead to life-threatening consequences.<sup>3</sup>

In this patient, you note that the patient's left chest tube had become kinked during positioning on the operating table. After you reposition the tube assuring its patency, the patient quickly stabilizes.

5)

After the patient's chest tube is repositioned and its patency is assured, the patient quickly stabilizes. You resume insufflation. The most common arrhythmia seen during laparoscopy is:

- A. Atrial fibrillation
- B. Sinus tachycardia
- C. Premature ventricular contractions

D. Sinus bradycardia

The most common arrhythmia that occurs during laparoscopic insufflation is bradycardia. A rapid stretch of the peritoneal membrane often causes a vasovagal response with bradycardia and occasionally hypotension. The appropriate management of this event is desufflation of the abdomen, administration of vagolytic agents (e.g., atropine), and adequate volume replacement.<sup>4</sup>

6)

Upon placing the scope into the intraabdominal cavity, you note small flecks of blood on the bowel. What is the grading of this hemoperitoneum?

- A. Grade 0
- B. Grade 1



C. Grade 2

D. Grade 3

**Bleeding can be quantified by a simple grading system. Grade 0 is a normal examination with increasing blood denoted by increasing grades. Depending upon the mechanism of injury, the surgeon may choose to observe patients with grade 1 hemoperitoneum. Grade 2 or 3 hemoperitoneum may require open laparotomy if the injury leading to bleeding cannot be identified or controlled laparoscopically.<sup>3</sup>**

**Grade 0: No blood is seen within the peritoneal cavity.**

**Grade 1: Small flecks of blood on the bowel or small amounts of blood in the paracolic gutters. Blood does not recur when aspirated. No bleeding sight is seen.**

**Grade 2: Blood is seen between loops of bowel and in the paracolic gutter. Blood recurs after aspiration.**

**Grade 3: Frank blood is aspirated from the Veress needle, or the intestines are noted to be floating on a pool of blood.<sup>5</sup>**

7)

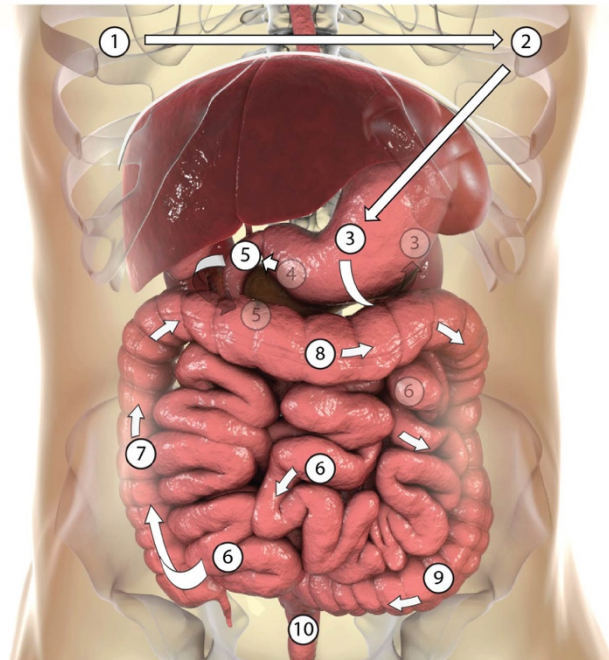
The flecks of blood appear to have emanated from the left upper quadrant. Prior to investigating a possible diaphragmatic injury, you should:

- a) **Perform systematic inspection of intraabdominal organs and retroperitoneum for injury**
- b) Decrease insufflation pressures to survey for bleeding
- c) Convert to open surgery
- d) Pack all quadrants laparoscopically

**A systematic inspection of intraabdominal organs and the retroperitoneum should now be undertaken. At least 50 percent of patients with diaphragmatic injuries have concomitant injuries. This exploration can be conducted laparoscopically if the operator has the expertise. Packing cannot be performed laparoscopically. If the patient is bleeding enough to require significant packing, conversion to open surgery should be performed immediately.**

**To ensure a standard systematic, complete inspection of intraperitoneal and, if required, retroperitoneal organs, we used a memory aid in the form of the following rhyme:**

- ① The right diaphragm and the liver,
- ② The left diaphragm and the spleen,
- ③ The stomach front, cut ligament and look from the back,
- ④ Remember the pancreas is behind,
- ⑤ The duodenum above and below,
- ⑥ Zigzag the bowel from treitz to cecum forward and back,
- ⑦ The right colon and behind,
- ⑧ The transverse colon over to the left colon,
- ⑨ And behind both transverse and left colon,
- ⑩ Down to the pelvis and give a second look.



8)

You perform a thorough diagnostic laparoscopy and note only the injury to the left diaphragm. There is a 3-cm laceration in the lateral dome of the diaphragm. There is no evidence of active bleeding. How would you address this injury?

- 1) Convert to open surgery for repair
- 2) Bridge the defect with mesh laparoscopically
- 3) Perform thoracotomy to repair from the thoracic cavity
- 4) **Perform primary repair laparoscopically**

**Diaphragmatic injuries are classified according to the American Association for the Surgery of Trauma (AAST) organ injury scale. Distinct from injuries to the liver, spleen, or kidney, increased morbidity and mortality has not been correlated to increasing injury grade in diaphragmatic injuries.<sup>1</sup>**

- **Grade I: Contusion**
- **Grade II: Laceration  $\leq 2$  cm**
- **Grade III: Laceration 2 to 10 cm**
- **Grade IV: Laceration  $>10$  cm; tissue loss  $\leq 25$  cm<sup>2</sup>**
- **Grade V: Laceration and tissue loss  $>25$  cm<sup>2</sup>**

**Diaphragmatic injuries on both the left and right should be repaired if possible. Laparoscopy is a safe approach to repairing acute traumatic diaphragmatic lacerations and chronic traumatic diaphragmatic hernias. Diaphragmatic lacerations can be repaired either with interrupted or running suture, preferring**



**nonabsorbable suture. However, in case of diaphragmatic disruption, prosthetic nonabsorbable mesh is used to reconstruct the diaphragm. In the majority of cases, chest tube drainage is required. The liver can sometimes impede visualization of the right diaphragm necessitating repair through a thoracoscopic approach.**

References:

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