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DIAGNOSTIC LAPAROSCOPY FOR TRAUMA

Abstract: Trauma is one of the leading causes of mortality in young patients worldwide. Multiple guidelines and management modalities have been suggested to provide optimal care and prognostic outcomes for these patients with minimal morbidity. One continuously evolving method in these guidelines is the laparoscopy. Laparoscopic interventions have positively affected patient outcomes for both trauma and elective surgical cases. Laparoscopy is the least invasive method to identify or exclude organ and visceral injuries and, if possible, reach a diagnosis. Therefore, with evolving techniques and improved practice, laparoscopy may potentially be a therapeutic option for patients with selected traumatic injuries.

In the management of trauma patients, laparoscopies have proven to be safer and more cost-effective than laparotomies in terms of hospital stay and the prevention of subsequent unnecessary laparotomies. Just few prospective randomized trials have been undertaken to compare the benefits of laparoscopies versus laparotomies in trauma cases. The present article aims to assess the indications for and outcomes of laparoscopy in trauma patients in comparison to traditional laparotomy methods and to outline the risks and benefits of each procedure.

Key words: laparoscopy, trauma, blunt, penetrating, risks

Laparoscopy has been used in the evaluation of trauma almost since the introduction of laparoscopy itself. Until recently however, this us limited to diagnostic laparoscopy. The recent development of video laparoscopes and the susequent explosion of laparoscopic procedures have paved the way for laparoscopic treatment of trauma, now a reality.[1]

Because both laparoscopic surgical tehniques and trauma care are frequent compnents of surgical practice, the potential of expansion of diagnostic and therapeutic laparoscopy in trauma is great. However, there are several aspects of trauma care

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which differentiate it from other diseases for which laparoscopic therapy has become preferred over the open approach. These include a high risk of morbidity and mortality[2], with the potential to increase the already high risk of death or disability if diagnosis are missed. The emergent and upredictable nature of disease forced rapid decision making, with the need for accurate therapy. The well known nocturnal nature of trauma leads to the middle of the night procedures, when specially trained laparoscopis teams are likely to be out of duty and when the operating room nurses who are on duty are unlikely to be familiar with laparoscopic equpment and procedures. For these reasons, laparosopy has been much slower to find the place in the fild of trauma than it has in other surgical areas. Nevertheless, the potential for reducing the incidence of negative and nontherapeutic laparatomies and shortening hospital stays is attractive. So, too, is the potential for a speedy return to work, particulary because trauma patients are likely to be yong and often are injuried in the most productive period of their life.[1]

Physiology and potential adverse effects

As trauma patients have varying degrees of shock and other preexisting phyhologic derangements, it is important to understand the physiology and potential adverse effects of pneumoperitoneum and laparoscopy. A surgeon who is aware of potential problems before they occure, can take appropriate measures to prevent known common complications. Several main features in laparoscopy and pneumoperitoneum are potentially harmful. Unfortunately, there is a little or meticulous scientific researchs that claryfies these data.

Victims of blunt or penetrating injuries who display ongoing hypotension or whose blood preasure is maintained only with constant resusitation procedures are not candidats for laparoscopic evaluation or treatment.[1,3] These patients are likely to have significant intraabdominal injury with a large amount of intraabdominal blood or significant ongoing bleeding. Presence of intraabdominal blood can be confirmed in 3-5 minutes with peritoneal lavage, and patients in whom such is found should be taken immidiately to the operating room for laparotomy and haemorrhage control. This leaves, as candidates for laparoscopy, a group of patients who have normal or stabile blood pressure, even though they may have had a period of hypotension. These are patients who are at significant risk of occult intraabdominal injury.[2-4] Likewise, these patients are at some risk for occult hemorrhagic shock. Up to 25% of the circulating blood volume may be lost before dyastolic hypotension is noted!. While trauma patients should always receive fluid resuscitation prior to intervention, there is no guarantee that each patient will have been optimally resuscitated. The patient may thus be left with some degree of ongoing shock, even if mild, which puts him/her at risk for complications from interventions that cause further cardiovascular and pulmonary compromise.

Unfortunately, there are four aspects of laparoscopic surgery that may contribute adverse effects on cardiopulmonary function: carbon dioxide, positive pressure pneumoperitoneum, hypothermia due to insufflations and anti-Trendelenburg positioning.[5]

Carbon dioxide, which is the gas used for performing pneumoperitoneum, is absorbable, resulting in acidosis, decreased stroke volume and increased pulmonary artery pressure. Hypercarboxemia is very well tolerated in the elective laparoscopic procedures, but not by the patient with hemorrhage, who already has mild to moderate grade of acidosis.

Under general anesthesia, patients are not breathing spontaneously, so they cannot increase their minute ventilation in order to *blow off* the excess carbon dioxide, so minute ventilation volumes must be increased during laparoscopy by anesthesiologist and arterial blood gases have to be monitored accurately.[1,3,6] Failure to terminate laparoscopic procedure in favor to open one when pCO_2 remains elevated, may result in arrhythmias, which may be difficult to treat in acidosis and hemorrhage.

It is well known that hyperventilation is one measure of treating people with severe head injury, as hyperventilation decreases intracranial pressure; as so, elevation of pCO_2 due to pneumoperitoneum is contraindicated for those patients.[1,6]

Insufflations may also result in hypothermia, as a result of fluid evaporation from the peritoneal surface. Also, insufflated gas is likely to be cold. Hypothermia can prolong patient's recovery room stay in elective laparoscopic procedure, with no major problems in recovery, but it is a serious problem in trauma. Many of trauma patients, especially ones with hemorrhage, are already hypothermic, also due to shock, cold resuscitation fluids and exposure. Significant core hypothermia (temp. less than 35^{o}C) contributes to coagulopathy and ventricular arrhythmias and increased morbidity and mortality in trauma, with 100% of mortality in group with core temperature of 32^{o}C or below. Therefore, monitoring rectal or esophageal core temperature during laparoscopic procedure in trauma is critical.

Positive pressure pneumoperitoneum is required for laparoscopic visualization and anterior abdominal wall elevation, ranges 10-15mm Hg. This pressure causes some degree of decrement of cardiac output, due to venous return to the hart (like the effect of PEEP). Many studies of the effect of pneumoperitoneum in cardiac output show little alteration. In contrast, laparoscopy for abdominal exploration in trauma requires anti-Trendelenburg position, which exacerbates the negative effects of pneumoperitoneum on cardiac output, resulting in about 25% decrease. Likewise, the effect of hemorrhage and pneumoperitoneum on cardiac output is additive and not entirely reversed by fluid resuscitation. Conditions as hemorrhage, hypothermia, anti-Trendelenburg position, hypercarbia, acidosis and pneumoperitoneum has negative effects on cardiac output and are sufficient to cause decompensation in patients with marginal cardiac reserve, or marginally compensated hemorrhagic shock.[1,3]

From the foregoing, it should be clear that laparoscopy in trauma holds potential hazards. Patients should be well evaluated, well resuscitated and volume status has been monitored with central venous pressure catheter, at least. In older patients or those with known cardiopulmonary compromise, a pulmonary artery catheter should be inserted for monitoring. Pneumoperitoneal pressure should be minimized (10 mm Hg)[1,2] and positioning should favor Trendelenburg or, at least, supine position.

In patients with diaphragm laceration, positive pressure will be transmitted into pleural cavity, resulting with tension pneumotorax[6]!

Therefore, trauma patients undergoing laparoscopy for trauma should have their chest draped and chest tube for an emergency chest decompression should be prepare close at hand.

One should keep on mind that large parenchymal laceration of solid organs such as liver and spleen may hide venous laceration[7]; it is possible that positive pressure in the peritoneum could lead to a massive gas embolism when pneumoperitoneal pressure exceeds venous pressure. Thus, caution in the case of parenchymal laceration of solid organs, even in the absence of bleeding, is warranted.

Blunt Abdominal Trauma

Non-invasive radiological imaging has shown good sensitivity and specificity in detecting intra-abdominal injuries following blunt abdominal trauma (97% and 98%, respectively). However, there is still a degree of ambiguity involved with certain splenic lacerations and pancreatic or gastrointestinal tract injuries.[2,8] The indications for the use of a laparoscopy in blunt trauma cases include evidence of a hollow viscous injury on CT scans or peritonitis on physical examination. Additionally, physical examinations may be unreliable due to a patient's altered mental status. However, as mentioned previously, hemodynamic stability is mandatory in the choice of a laparoscopic intervention over a traditional laparotomy. Diaphragmatic injuries have also been associated with blunt trauma, manifesting as larger ruptures and tears in comparison to penetrating trauma. These injuries account for 2.1% of patients with blunt trauma injuries. Laparoscopic examinations can confirm the presence of blunt trauma injuries but a laparotomy is still essential in cases of large tears.[1,3,8]

Penetrating Injuries

Penetrating abdominal trauma, including stabbing and gunshot-related wounds, is one of the most common causes of mortality in trauma patients. This form of trauma does not have to penetrate the peritoneal cavity itself — some injuries can

be tangential without violating the peritoneum. In one study, it was estimated that 45% of patients with normal hemodynamic parameters who sustained a penetrating abdominal wound had a tangential path of injury.[2] Therefore, there is a need to develop an accurate and sensitive diagnostic modality to identify patients with true penetration of the peritoneum. Laparoscopies have shown superior specificity and sensitivity in identifying peritoneal penetration when compared to CT and focused assessment with sonography for trauma (FAST). In a study conducted to analyse 10 years of laparoscopy experience in a level-one trauma centre, 83% of the 131 patients who underwent laparoscopic interventions had a penetrating abdominal injury.[1,9] The indications for a laparoscopy in these patients included a gunshot wound involving the flanks, an anterior abdominal stab wound with *fascia* penetration, evidence of peritonitis on FAST scans and uncertainty regarding the tangential path of injury. Had any of these patients experienced a decline in vital signs, a laparotomy would have been the modality of choice.[1,9]

Diaphragmatic Injuries

One of the most common injuries associated with penetrating trauma is a diaphragmatic tear or rupture. Thoracoabdominal trauma is any injury within the region bounded by the posterior nipple line superiorly to the costal margin inferiorly.[1] Diaphragmatic injuries should always be suspected in such conditions, as they can be easily missed during the initial diagnosis. Powell *et al*. found that 20% of patients who sustained penetration to the thoracoabdominal area developed a diaphragmatic injury. A study estimating mortality and morbidity due to complicated diaphragmatic injuries reported rates of 20% and 30%, respectively. The most common complication of a diaphragmatic injury is the herniation of abdominal content into the thorax which, if untreated, can cause complications that can lead to death. Accordingly, ruling out violations or breaches of the diaphragm is crucial. Unfortunately, non-invasive imaging modalities (CT and US) have been associated with high false-negative rates in the diagnosis of diaphragmatic injuries. In addition, Mihos *et al*. reported that 74% of traumatic diaphragmatic injuries in their study were diagnosed intra-operatively after being missed initially on noninvasive imaging.[9,10] A laparoscopy enables visual examination of the left lobe of the diaphragm and, to a lesser extent, the right lobe, which would otherwise be obscured by the liver on imaging. Direct laparoscopic visualisation of the diaphragm has been shown to be very good diagnostic modality to identify diaphragmatic tears and ruptures. However, CT scans remain the standard imaging modality in patients involved in trauma.[1,2,10] Video-assisted thoracoscopy remains the best diagnostic method for diaphragmatic injuries.

Laparoscopy is the safe and feasible diagnostic method applied properly by experienced surgeons. Laparoscopy decreases the number of negative laparatomies in selected, hemodynamic stable group of patients with abdominal trauma.

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