

The Role of Minimally Invasive Surgery in Pediatric Trauma



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KEYWORDS

• Minimally invasive surgery • Trauma • Laparoscopy • Thoracoscopy

KEY POINTS

- Laparoscopy and thoracoscopy possess high levels of diagnostic accuracy with low associated missed injury rates.
- Minimally invasive surgery (MIS) is used in pediatric trauma patients who are hemodynamically stable.
- MIS offers diagnostic and therapeutic capabilities in pediatric trauma patients.
- MIS confers a lower postoperative morbidity profile than traditional open approaches.

The role of minimally invasive surgery (MIS) in the management of blunt and penetrating injuries to the chest and abdomen has evolved over the last 3 decades. In 1972, Gans and Berci first demonstrated the diagnostic capacity of laparoscopy in 16 children and shortly after Carnevale and associates published a broad experience with laparoscopy in trauma patients.^{1,2} Subsequently, several groups published case series demonstrating both the safety and efficacy of laparoscopy in trauma, and perhaps more importantly its effect on reducing nontherapeutic laparotomy rates by up to 60% in both blunt and penetrating injury.³⁻⁵ Although early technical limitations precluded the full diagnostic and therapeutic potential of MIS, this was quickly overcome. MIS is now routinely used as a therapeutic strategy encompassing the full spectrum of traumatic injuries, including repair of lung, diaphragm, bowel, pancreas, and solid organ injuries.⁶⁻¹⁰

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The current gold standard therapeutic intervention for an unstable patient with blunt or penetrating abdominal injury remains exploration through a midline laparotomy; similarly, a sternotomy or thoracotomy may be required in the unstable patient with a thoracic injury. It is important to note, however, that negative open exploration carries with it a significant mortality of up to 5% and an 18% incidence of morbidity. Most notably, this includes the risk of future adhesive intestinal obstruction and potential for abdominal wall hernia.¹¹ Across pediatric and adult case series, diagnostic and therapeutic laparoscopy has demonstrated significant benefit for the treatment of traumatic injuries. In hemodynamically stable patients requiring exploration, MIS offers a safe diagnostic or therapeutic alternative with several advantages, including less pain, shorter recovery time and hospital stay, and decreased financial burden, as well as decreased morbidity and mortality through avoidance of unnecessary procedures.^{12,13} In an examination of the National Trauma Data Bank, Zafar and colleagues¹⁴ evaluated 916 patients at 467 trauma centers undergoing therapeutic laparoscopic interventions for blunt and penetrating trauma, including diaphragm repair, bowel repair or resection, and splenectomy. The authors found that patients treated with therapeutic laparoscopy had a significantly shorter hospital stay with no increased risk of mortality or morbidity compared with patients undergoing laparotomy. In addition, the accuracy of MIS in diagnosing traumatic injury approaches 100%, with several studies documenting zero missed injuries in pediatric trauma patients.^{12,15,16} Further, maintaining the intestines within the peritoneal cavity prevents tissue desiccation and minimizes fluid and temperature shifts.⁸ Across pediatric and adult case series, diagnostic and therapeutic laparoscopy has demonstrated significant benefit for the treatment of traumatic injury to the abdomen and thorax.

Children suffer higher rates of solid organ injury than adults from both blunt and penetrating trauma because they have proportionally larger solid organs, less subcutaneous fat, and less protective muscle.¹⁷ Blunt abdominal trauma related to motor vehicle collision is the most common cause of unrecognized fatal injury in children, and approximately one third of children with major trauma will suffer intraperitoneal injuries.¹⁸ The Advanced Trauma Life Support system outlines the initial evaluation and management of children with traumatic injuries and follows the same sequence as that in an adult: primary survey, resuscitation, secondary survey, and definitive care. The management of children with solid organ injury after blunt abdominal trauma has evolved significantly since Upadhyay and Simpson¹⁹ in 1968 first suggested the nonoperative management of splenic trauma in children. Hemodynamically unstable children with free fluid identified on ultrasound examination proceed immediately to exploratory laparotomy, whereas hemodynamically stable children with free fluid on ultrasound examination undergo computed tomography. This strategy has demonstrated accuracy in identifying greater than 95% of intraabdominal injuries.²⁰ Diagnostic peritoneal lavage in the pediatric population has become relatively obsolete owing to the diagnostic accuracy of high-resolution computed tomography and Focused Abdominal Sonography for Trauma examinations. Currently, children who suffer blunt abdominal trauma with solid organ injury involving liver and/or spleen are now managed according to the ATOMAC guideline used at many pediatric trauma centers.²¹ The ATOMAC protocol for the management of blunt liver or spleen injury guides the surgeon along a nonoperative management pathway until the child develops recurrent hypotension, bleeding, or fails to have a sustained response to blood transfusion. When surgery is indicated, MIS offers diagnostic and therapeutic equivalency to open surgery in the hemodynamically stable child.

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