Solid organ injury in Blunt abdominal trauma in pediatrics: Ain Shams university hospitals practice and review of literature

A thesis
Submitted By

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Ayman Mostafa Desouky

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List of Abbreviations

AAST	:	American association of the surgery of trauma
ACS	:	Abdominal compartmental syndrome
ACS	:	American College of surgeons
AIS	:	Abbreviated injury scale
ALARA	:	As low as reasonably achievable
ALT	:	Alamine Aminotransferase
APSA	:	American pediatric surgery association
AST	:	Aspartate Aminotransferase
ATV	:	All-terrain vehicle
AVPU	:	Alert, voice, pain, unresponsive
CDC	:	Centers for Disease control and prevention
CT	:	Computed tamography
ED	:	Emergency department
ERCP	:	Endoscopic Retrograde cholangiopancreatography
ETT	:	Endotracheal tube
FAST	:	Focused assessment by sonography in trauma
FFP	:	Fresh frozen plasma
GCS	:	Glasgow coma scale
IAH	:	Intra-abdominal hypertension
IAP	:	Intra-abdominal pressure
ISS	:	Injury severity score
IV	:	Intravenous
LOS	:	Length of stay

List of Abbreviations (Cont.)

MRCP	:	Magnetic retrograde cholangiopancreatography
MRI	:	Magnetic Resonance imaging
MVC	:	Motor Vehicle crashes
NAT	:	Non-accidental trauma
NISS	:	New injury severity score
NOM	:	Non-operative management
NPTR	:	National pediatric trauma registry
PICU	:	Pediatric intensive care unit
PRBC	:	Packed red blood cells
PTS	:	Pediatric trauma score
RTS	:	Revised trauma score
SCIWORA	:	Spinal cord injury without radiographic abnormalities
TPN	:	Total parentral nutrition
US	:	Ultrasound

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Introduction

The influence of Simpson's 1968 publication on the successful non-operative treatment of select children presumed to have splenic injury has been extremely influential. Initially suggested in the early 1950s, the era of non-operative management of splenic injury began with the report of 12 children treated between 1956 and 1965. The diagnosis of splenic injury in this select group was made by clinical findings, along with routine laboratory and plain radiographic findings. Keep in mind that this report predated ultrasonography, computed tomography, or isotope imaging. Subsequent confirmation of splenic injury was made in one child who required laparotomy years later for an unrelated condition, when it was found that the spleen had healed in two separate pieces ***(Upadhyaya and Simpson, 1968).***

Historically, adult trauma surgeons unfamiliar with the non-operative management of solid organ injuries raised doubts about the wisdom of this approach. Their concerns included the potential for increased transfusion requirements, increased length of hospitalization, and missed associated injuries. Some even questioned the need for involvement of pediatric surgeons in pediatric trauma care. Success of non-operative management has been slowly acknowledged by colleagues in adult trauma care and many of the principles learned in pediatric trauma is being applied to their patients ***(Malhotra; et al., 1990).***

A review of the National Pediatric Trauma Registry indicated that 8% to 12% of children suffering blunt trauma have an abdominal injury. Fortunately, more than 90% of them survive. Although abdominal injuries are 30% more common than thoracic injuries, they are 40% less likely to be fatal. The infrequent need for laparotomy in children with blunt abdominal injury has created a debate regarding the role of pediatric trauma surgeons in their treatment. Analyses of the NPTR and the National Trauma Data Bank emphasize the overall "surgical" nature of pediatric trauma patients, with more than 25% of injured children requiring operative intervention. Clearly, a qualified pediatric trauma surgeon would be the ideal coordinator of such care ***(cooper; et al., 1994) (Tepas; et al., 2003) (Acierno; et al., 2004).***

Few surgeons have extensive experience with massive abdominal solid organ injuries requiring immediate surgery. It is imperative that surgeons familiarize themselves with current treatment algorithms for life-threatening abdominal trauma. Important contributions have been made in the diagnosis and treatment of children with abdominal injury by radiologists and endoscopists. The resolution and speed of CT, the screening capabilities of focused abdominal sonography for trauma, and the percutaneous, angiographic, and endoscopic interventions of non-surgeon members of the pediatric trauma team have all enhanced patient care and improved outcomes ***(Stylianos and Pearl, 2006).***

Aim of the work

This study aimed at reviewing the literature about the management of blunt abdominal trauma in children with solid organ injuries and presenting the practice of pediatric surgery department in Ain Shams University in 6 months period.

Chapter 1

Anatomic and Physiological Differences Between Children And Adults

There are considerable differences between pediatric and adult trauma patients including body proportions, anatomic variations in size, ossification of the skeleton, physiologic responses to injury, patterns of injury, and psychological, social and emotional needs ***(Frank; et al.,2014)***.

Efficient and effective airway management is a critical aspect for pediatric trauma since inadequate ventilation and hypoxia are the most common causes of pediatric cardiopulmonary arrest following trauma. The unique features of pediatric and infantile airway anatomy and respiratory physiology make airway management one of the most challenging components of pediatric trauma care. Small children and infants have relatively large heads that may result in flexion of the airway and neck causing airway obstruction in the unconscious patient. Children also have a more anteriorly and superiorly positioned larynxes, small oral cavities, relatively large tongues in comparison to adults, limiting visualization of the airway during interventions. Because of the relatively short tracheas of pediatric patients, once they are intubated they are at increased risk of endotracheal tube displacement, either into the right main stem bronchus or accidental extubation if the tube is under tension. When transferring pediatric patients, tube should be adequate, appropriately secured, with proper sedation and close monitoring that can help prevent complications ***(Stafford; et al., 2002).***

Children are better able to maintain relatively normal blood pressure despite significant blood loss in comparison to adults. Multiple studies have shown that a perfusing pressure can be maintained in pediatric patients with up to 35-40% blood loss prior to becoming hypotensive. Furthermore, infants and small children must increase their heart rates to improve cardiac output and increase stroke volume. Therefore, Intervention should be timed appropriately before hypotension occurs and any interventions or medications that decrease heart rate that may cause a rapid and detrimental loss of perfusion should be used cautiously ***(Schwaitzberg; et al., 1988).***

Head injuries are potentially more dangerous in children than in adults for several reasons. First, the delicate nature of developing neural tissue and the softer bones of the pediatric skull allow direct transmission of impact forces to the underlying brain, especially at points of bony contact. Second, intracranial bleeding in infants may, on rare occasions, be severe enough to cause hypotensive shock because skull fontanelles and sutures remain open. Third, the proportionately larger size of the head, when coupled with the commonly observed injury mechanisms in children, generally leads to head trauma with a loss of consciousness. Consequently, the voluntary muscles of the neck lose their tone which can lead to hypoxia and soft tissue obstruction in the upper airway. Hypoxia causes potentiation and exacerbation of the initial traumatic injury to the brain (secondary insults) ***(Cooper, 2014)***.

Cervical spine injury is a relatively uncommon event in pediatric trauma. It affects approximately 1.5% of all seriously injured children, and occurs at a rate of 1.8/100,000 population, in contrast to closed-head injury, which occurs at a rate of 185/100,000 population ***(Kewalramani; et al.,1980)(Kokoska; et al.,2001) (Patel; et al., 2001).***

The pediatric surgeon should also be aware of normal variants of cervical spine anatomy. The greater elasticity of the interspinous ligaments and the more horizontal apposition of the cervical vertebrae also give rise to a normal anatomic variant known as pseudo-subluxation, which affects up to 40% of children younger than age 7 years. The most common finding is a short (2-3 mm) anterior displacement of C2 on C3, although anterior displacement of C3 on C4 also may occur. This pseudo-subluxation is accentuated when the pediatric patient is placed in a supine position, which forces the young child's cervical spine into mild flexion because of the forward displacement of the head by the more prominent occiput. The increased distance between the dens and the anterior arch of C1 that is found in up to 20% of children is also attributed to the greater elasticity of the interspinous ligaments ***(Bohn; et al., 1990).***

When an injury to the cervical spine does occur, it frequently occurs at C1, C2, and the occipitoatlantal junction. These injuries are above the nerve roots that give rise to diaphragmatic innervation (C4) and predispose the afflicted child to paralysis as well as respiratory arrest. The increased angular momentum produced by movement of the proportionately larger head, the more horizontal apposition of the cervical vertebrae and the greater elasticity of the interspinous ligaments are responsible for this spectrum of injuries. Subluxation without dislocation may cause spinal cord injury without radiographic abnormalities (SCIWORA). SCIWORA accounts for up to 20% of pediatric spinal cord injuries as well as a number of prehospital deaths that were previously attributed to head trauma ***(Pang and Wilberger, 1982)(Bosch; et al., 2002).***

Most spinal injuries in young children involve the upper c-spine due to their relatively larger heads that create a fulcrum-like effect on the upper c-spine region, in contrast to adults who are more likely to suffer lower c-spine injuries. If there is concern for ligamentous injury or spinal cord injuries without radiographic abnormality, patients should be placed in an extended wear rigid collar and best evaluated in concert with a pediatric spine specialist and may require MRI ***(Wackett; et al., 2007).***

The pediatric skeleton is more susceptible to fractures because the periosteum in childhood is more resilient, elastic, and vascular whereas cortical bone is highly porous. This results in higher percentages both of incomplete (torus and greenstick) fractures and complete, but non-displaced fractures. Long-term growth disturbances may also complicate childhood fractures. Diaphyseal fractures of the long bones cause significant overgrowth whereas physeal (growth plate) fractures cause significant undergrowth. Unless treated, both result in limb length discrepancies ***(Ogden, 1990)***.

In contrast to adults, the thorax of the child usually escapes major harm because the pliable nature of the ribs and cartilage allows the kinetic energy from forceful impacts to be absorbed without significant injury, either to the chest wall itself or to underlying structures. However, for several reasons, the abdomen of the child is more vulnerable to injury. Anatomically, the smaller size of children, as compared to adults, results in closer organs proximity. The pelvic girdle, abdominal wall and rib cage are underdeveloped and provide less protection to the abdominal contents. Flexible ribs cover only the uppermost portion of the abdomen. In addition, children have less body fat, and hence, less ‘padding’ to diffuse and absorb external force. Also, the pelvis is shallow, lifting the bladder into the abdomen. Moreover, the overall small size of the abdomen predisposes the child to multiple rather than a single injury as energy is dissipated from the impacting force. Finally, gastric dilatation due to air swallowing (which often confounds the abdominal examination by simulating peritonitis) leads to circulatory and ventilatory compromise by limiting the diaphragmatic motion, increasing the risk of pulmonary aspiration of gastric contents, and causing vagally mediated dampening of the normal tachycardic response to hypoxia caused by hypoventilation or hypovolemia ***(Cooper, 2014)***.

Fortunately children are generally healthy and have fewer underlying medical problems than adults, from the physiologic perspective. It is uncommon for children to be on medications, especially those that potentially affect hemodynamics or hemostasis. Therefore, injured pediatric patients are better able to effectively compensate for physiologic insults such as acute blood loss. It is generally accepted that children can lose up to 45% of their circulating blood volume, and exhibit tachycardia as the only abnormal vital sign. Persistent hypotension is an ominous finding, suggesting the potential development of irreversible shock and the failure of compensatory mechanisms. The normal variability of vital signs depending on age complicates the evaluation of injured children ***(Trauma AcoSCo, 2004).***

The susceptibility of children for major renal trauma compared to adults appears in part secondary to the fact that the abdominal musculature is weaker, the kidney occupies a relatively larger amount of the retroperitoneal space, the thoracic cage is less well ossified and there is less cushioning from perirenal fat ***(Brown; et al., 1998).***

Although anatomical differences leave children more susceptible to sever traumatic injuries than adults, their unique physiological compensation abilities and rapid