

BLUNT ABDOMINAL TRAUMA IN CHILDREN – A PRACTICAL REVIEW

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Abstract

Blunt abdominal trauma is a major morbidity and mortality factor in all age groups, and especially in children it is the most common cause of intraabdominal injury. In the past two decades, the use of computer tomography images and nonoperative treatment of haemoperitoneum are important steps in the therapeutic management of abdominal trauma in children. The advantages of the conservative approach are reduced cost of hospitalization, faster discharge by avoiding non-therapeutic celiotomies, fewer intraabdominal complications and reduced transfusion rates associated with a global improvement in mortality rates.

This paper is a review of blunt abdominal trauma in children and a comparative study was carried out between the literature and the methods of therapeutic management used in the Clinic of Pediatric Surgery of "Sf. Apostol Andrei" Emergency Clinical County Hospital of Constanta.

Keywords: abdominal trauma, blunt abdominal trauma, abdominal injury, splenic injury, liver injury, hollow viscus injury, children

Introduction

Blunt abdominal trauma is a major morbidity and mortality factor in all age groups, and especially in children it is the most common cause of intraabdominal injury [1,2]. The identification of intraabdominal lesions is still very difficult, many lesions may occur after the initial assessment and treatment. In the past two decades, the use of computer tomography images and nonoperative treatment of haemoperitoneum are important steps in the therapeutic management of abdominal trauma in children. The advantages of the conservative approach are reduced cost of hospitalization, faster discharge by avoiding non-therapeutic celiotomies, fewer intraabdominal complications and reduced transfusion rates associated with a global improvement in mortality rates [3,4].

In addition to the CT exam, which is the first option in this pathology, laboratory tests and ultrasonography help the diagnose. However, it is important to note that anamnesis and a correct clinical examination, through primary and secondary emergency assessment, prompt resuscitation and

close monitoring, are essential maneuvers that make the difference between life and death.

Purpose

A review of blunt abdominal trauma in children and a comparative study was carried out between the literature and the methods of therapeutic management used in the Clinic of Pediatric and Orthopedic Surgery of "St. Apostol Andrei" Emergency Clinical County Hospital of Constanta.

Material and method

We have studied over 150 articles from the literature using online search engines and PubMed, Med-Line, Clinical Key, Ovid databases. Terms such as *abdominal trauma*, *blunt abdominal trauma*, *abdominal injury*, *splenic injury*, *liver injury*, *hollow viscus injury* have been used. Scientific articles, controlled randomized trials, protocols, meta-analyses, and reviews have been checked. This review allowed us to make a synthesis of conservative management of abdominal trauma in children compared to the diagnostic and treatment techniques of the Clinic of Constanta.

Results and discussions

In children, accidents caused by motorised vehicles represents about 60% of causes for blunt abdominal injuries. Then falls and bicycle injuries are second [5]. 10% of cases from accidents represent lap belt injuries [6]. There is a significant percent of children without history of accidents or the details are concealed by the parents. The management of these cases is very difficult and attention must be paid not to miss important injuries [7].

Following the retrospective statistical study we observed that out of 565 polytrauma children hospitalized between 2012-2016, only 248 associated abdominal trauma. The frequency is higher in urban than in rural areas (145 cases in urban areas versus 103 cases in rural areas). Like in adults, first place in children trauma etiology is occupied by road accidents, followed in frequency by falls from heights, play accidents or aggression. Causes that generated polytrauma and polytrauma associated with abdominal trauma are listed in order of frequency (Table 1).

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Table 1. Etiology of polytrauma in our study.

Etiology	No. of cases of polytrauma associated with abdominal trauma	Other lesions associated with abdominal trauma
Road accidents	153	196
Falls from heights	83	106
other causes	12	15

Injury patterns in children differ from those in adults because of the size of the patients. When compared to adults the abdominal organs are closely packed together. Children have a thin abdominal wall, with relatively little abdominal muscle or fat mass, which can absorb some of the impact. The ribcage is very elastic, offering less protection to the liver and spleen. Also, the diaphragm is placed more horizontally, thus displacing the liver and spleen downwards, which further increases the vulnerability of the intra-abdominal organs. This is because the child's ribs do not absorb the force that adult ribs absorb while fracturing. Fractured ribs are rare in children [1]. Children have a relatively small pelvis placing the bladder more intra-abdominally and thus less protected. All these factors contribute to the vulnerability of the abdomen in children [8].

Principles of acute trauma care do not differ between children and adults, but in children even "simple" interventions such as placement of an intravenous catheter can be more difficult because of the smaller size of the vessels. For all these reasons, the child with possible severe trauma can therefore pose a significant challenge for physicians.

Hypothermia develop rapidly in children because of large skin area. Acidosis and coagulopathy, combined with hypothermia represent a fatal triad. In conclusion, hypothermia should be avoided whenever possible, during case management.

There are some differences in responses to stress between children and adults. Hemodynamic stability can be easily maintained in children only with discreet signs for a long period of time, before they rapidly develop severe hypovolemic shock. Bradycardia is very dangerous in children and it must be considered as a lethal sign.

In the emergency room injured children undergo primary survey, following through the ATLS/APLS principles: ABC (DEFG) and following the idea - treat first what kills first [9]. A patent airway, with in-line cervical spine immobilization, is secured and adequate ventilation established. This is followed by restoration of satisfactory circulating blood volume [1].

Usually, the examination of the abdomen is not a part of the primary survey, but may be included in maintaining under control the circulation, if there are signs of haemodynamic instability despite ongoing fluid resuscitation. Vital parameters are age-dependent. At a loss of more than 15% of the total circulating volume, it will appear the signs of hypovolemic shock. Severe hypotension will occur only after an acute loss of 25% of the total circulating volume. In case of hypovolemic shock, a bolus

of 20 ml/kg warm isotonic crystalloid is administered. This process can be repeated. In the first stage an amount of 25% of the circulating volume is assured, after the second maneuver 50% of the volume has been replaced. In comparison to the adults, in children, in case of hypovolemic shock there might be an increased systolic pressure due to the shock response.

A precise history of the mechanism of injury is important in the management of blunt abdominal trauma. The initial clinical assessment of children with abdominal injuries is often difficult. The most important signs and symptoms in awake patients are as follows:

- ✓ Pain
- ✓ Tenderness
- ✓ Gastrointestinal hemorrhage
- ✓ Hypovolemia
- ✓ Evidence of peritoneal irritation.

However, large amounts of blood can accumulate in the peritoneal and pelvic cavities without any significant or early changes in the physical examination findings. Bradycardia may indicate the presence of free intraperitoneal blood [10].

Physical examination may be unreliable in up to 30 per cent of children, particularly when the child has a reduced level of consciousness [11].

On physical examination, the following injury patterns predict the potential for intraabdominal trauma:

- ✓ Lap belt marks: children in accidents involving moderate to high speed frontal deceleration while being restrained by a seat belt are at high risk of sustaining a constellation of injuries known as the 'lap belt complex' [12,13]. This consists of a flexion-distraction injury to the lumbar spine (a fracture is possible), ecchymosis of the abdominal wall, and injury to the intestine [13].
- ✓ Ecchymosis involving the flanks (Grey Turner sign) or the umbilicus (Cullen sign): Indicates retroperitoneal hemorrhage, but is usually delayed for several hours to days
- ✓ Abdominal distention
- ✓ Auscultation of bowel sounds in the thorax: May indicate a diaphragmatic injury
- ✓ Local or generalized tenderness, guarding, rigidity, or rebound tenderness: Suggests peritoneal injury
- ✓ Fullness and doughy consistency on palpation: May indicate intraabdominal hemorrhage
- ✓ Creptitation or instability of the lower thoracic cage: Indicates the potential for splenic or hepatic injuries [14].

The inspection of the abdomen should look for bruising, movement with respiration, lacerations, distension, and seat belt marks. There is a high probability that major lesions of the internal organs can occur without any external signs.

Gentle palpation should be carried out to reveal any areas of tenderness. Care should be taken not to hurt the child because their continued cooperation is important during repeated examination [1].

A maneuver that must be carried out during the assessment of a potential abdominal trauma child is the gastric drainage. In children with serious injuries air swallowing and dilatation of the stomach is common. Gastric distension can mimic an abdominal lesion and goes to rerespiratory distress. Also venous circulation can be compromised. Clinical signs of abdominal trauma may change rapidly after the insertion of a gastric catheter [14]. Gastric intubation also reduces the risk of aspiration of food contents in unconscious children.

In a complete evaluation for multiple trauma, rectal and vaginal examination are routine in adults, but in children these maneuvers are mandatory only if rectal, spinal or urethral injuries are suspected. Tenderness, boggy, or a floating prostate are important signs, but may be difficult to ascertain with confidence in a child who is bound to be frightened by this examination [1].

If there are signs of rectal bleeding, a careful examination must be done under general anesthesia. Superficial injuries to the rectal mucosa or anal canal will resolve with conservative management. Full thickness injuries below the internal sphincter can be treated by primary repair whereas injuries above the internal sphincter may need a diverting colostomy [15].

After the examination of the genital area, a urinary catheter is mandatory for monitoring the liquid output and the evolution of the state of the patient during initial treatment. One has to be very careful with children who may have urinary tract lesions. These lesions may be present if there are signs of trauma, ecchymosis or swelling of the genital organs or perineum. If blood is present in the meatus or there is a visible haematuria, for sure we speak of urinary tract lesions. This state also goes with the inability to void or sensation of voiding without the passage of urine. Is better to avoid catheterisation in case of suspicion of an urethral injury, not to create more harm than good, to transform a partial tear of the urethra in a complete one [1].

During a complete evaluation, the physical examination is doubled by investigations, done during the primary survey and especially during secondary assessment. First of all an intravenous catheter during the first stage of assessment is mounted for different purposes:

- Cell count;
- Blood grouping and cross-matching;
- Electrolytes;
- Specific tests for:
 - o Pancreatic or small intestine trauma – serum amylase
 - o Liver lesions – transaminase

Beware of the fact that elevated amylase in the serum may be present if there are lesions of the parotid glands [16].

In a prospective study of 49 children younger than 12 years of age who were being evaluated for child abuse (without any physical sign of abdominal injury), four had elevated transaminase levels, of whom, three had liver

lacerations documented by subsequent abdominal computed tomography (CT) scans [16].

Urinalysis is another important test during the evaluation of an abdominal trauma child. Haematuria is an important marker not only for kidney lesions, but also for other abdominal injuries that not include the genitourinary tract. In one study of 378 consecutive children undergoing abdominal CT following blunt abdominal trauma who were evaluated for haematuria, 66% were found to have haematuria (220 had occult haematuria and 36 had gross haematuria). Organs injured in those with haematuria were: spleen (37%), liver (33%), whereas renal injury was seen only in 26% [17]. In another study of children with post-trauma haematuria with normal radiology of the genitourinary tract, 77% had an underlying hepatic, splenic, or pancreatic injury [18].

It is proven that if there are less than 4 red blood cells seen on microscope, this is the result of the catheter passage [19]. The literature has different opinions concerning kidney trauma and the quantity of haematuria:

- Stalker et al. more than 50 red blood cells (RBC) seen on microscope - significant of renal injury [20];
- Lieu and et al. said that greater than 20 RBC was significant [21];
- Taylor et al. believed that asymptomatic haematuria usually indicates insignificant urinary tract injury [22];
- Carroll and McAninch – haematuria is important but non-specific and not a predictor of the severity of the injury [23].

The literature says that in addition to the mechanism of injury and physical examination, the amount of haematuria is a factor in the decision of CT imaging [24,25].

Diagnostic peritoneal lavage in children is not very used today. The usage of this technique has rapidly declined because of the fact that many lesions of the solid organs in children are managed more and more conservatively. This maneuver may be used in the following cases [10]:

- Lesions of the spinal cord
- Patients with shock, which cannot be explained and with polytrauma
- Multiple trauma with a possible abdominal injury
- Intoxicated patients with a possible abdominal injury
- Patients with a possible abdominal lesions who will suffer a longterm anesthesia.

There are many disadvantages in using this technique in children: it is very painful, that's way it must be done under general anesthesia and itself can cause other abdominal lesions. The only time when this procedure is useful is the last point of the above paragraph, the necessity of excluding an abdominal lesions before a surgical procedure of other kind in a polytrauma patient [1].

Imaging tests complete the assessment of children with potential abdominal injury. Ultrasonography is a very useful, rapid, portable, noninvasive and accurate investigation to see if there is free intraabdominal fluid in the peritoneum [26]. The current focused abdominal sonography in trauma (FAST) examination protocol consists of 4 acoustic windows (pericardiac, perihepatic, perisplenic, pelvic) with the patient supine. An examination is

interpreted as positive if free fluid is found in any of the 4 acoustic windows, negative if no fluid is seen, and indeterminate if any of the windows cannot be adequately assessed [10,27].

This test is sensitive, but it alone cannot put the diagnosis of organ lesion, so it is useful only as an indication of a CT scan. Also is useful if there is a suspicion of intraabdominal bleeding in a trauma child that doesn't answer to fluid resuscitation.

Radiographs of the trunk (thorax, abdomen and pelvis) must be done during primary assessment of children with potential abdominal injury. A X-ray of the abdomen is useful to see the position of the stomach and also the models of intestinal gas distribution – paralytic ileus or oedema of the intestinal wall; presence of gas directly in the peritoneum.

Indirect signs of solid organ injuries (spleen, liver) may be suspected when there are rib fractures, displacement of the diaphragm or other neighbourhood organs or pleural effusion in the base of the lungs [28,29].

A normal chest or pelvic X-ray can't exclude itself a lesion of the abdomen in children.

Computed tomography has remained the first in the management of paediatric abdominal trauma since 1980, when Rance and Bear, first reported its use in stable trauma children [30].

This investigation can provide very detailed images of the solid organs, duodenum and genitourinary system and it

is used in determining the operative intervention or conservative management of haemoperitoneum [31].

There are some specific situations when CT scan is needed in the assessment of abdominal trauma child:

- Unexplained blood loss
- Unreliable physical examination
- Potential brain injuries
- Signs of intraabdominal fluid on X-rays and ultrasonography [32].

Until about four decades ago, in the 80s, laparotomy was the elective method in treating patients with haemoperitoneum. Because of opening of peritoneal cavity, lesions of the spleen and liver would often go to splenectomy or partial hepatectomy [1].

With conservative treatment and proper resuscitation and fluid therapy, it has been proven that many solid organ lesions may heal without surgical intervention. This practice avoids potentially fatal sepsis, especially after splenectomy in children [33].

In our study, conservative treatment had an important role in the management of abdominal trauma in children, with more than two thirds from the total of 248 cases (see Figure 1). These cases were carefully selected after different factors: haemodynamic stability, without visceral organs lesions or only in cases with grade I and II of spleen injuries or cases of grade I to grade IV hepatic injuries, some cases of kidney injuries and retroperitoneal haematoma. All children with signs of bowel perforation (6 cases) underwent laparotomy.

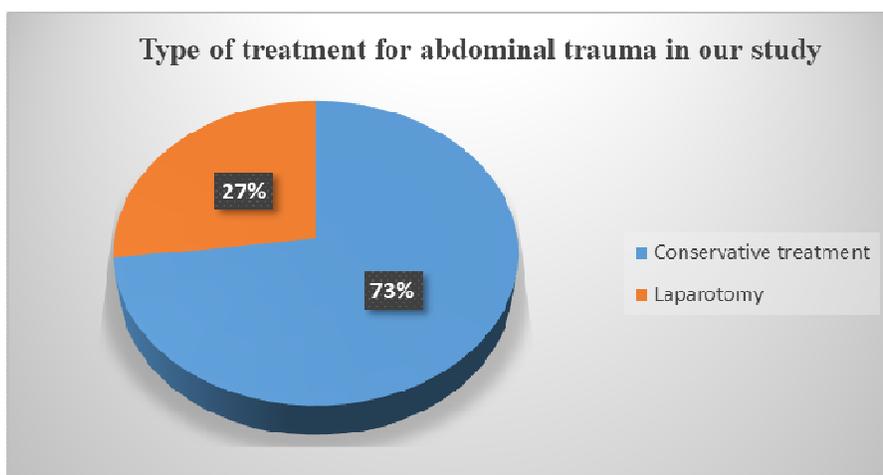


Figure 1. Type of treatment for abdominal trauma in our study.

The stability of the patients are vital. Those patients who require transfusion less than 40% of blood volume can be managed conservatively [34].

Other authors consider that the level of haemoglobin is not dropping below 7 mg/mm³, these children can be treated nonoperatively [35]. If the child is unstable and also

requires more than 40 ml/kg of blood, requires surgical intervention [1].

Proper resuscitation and specialised monitoring and intensive care is vital for the conservative treatment of these difficult cases. So these children suffering abdominal injuries must be treated in a trauma center with pediatric department.

Conclusions

- In our study, more than two thirds of cases with abdominal trauma were treated conservatively;
- All cases with visceral organs injuries were treated by laparotomy;
- The unique features of traumatized children, both physiologically and anatomically, require specific

trauma regional centers nationwide to serve the whole country;

- Specific protocols for the management of the trauma child should be developed, different from those of the adult due to the specific physiological and anatomical elements of the child.

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