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Abdominal Injuries In Child Abuse

—by Dirk Huyer

Major blunt abdominal trauma due to child abuse is a serious, if infrequent form of morbidity and mortality in childhood (Cooper et al., 1988). The vast majority of abusive abdominal injuries result from blunt trauma, with penetrating injuries being much less common, although a recent increase has been reported (Ramenofsky, 1987). Several authors (Caniano, Beaver, & Boles, 1986; Cooper et al., 1988; Kirks, 1983) have reported between 0.5 and 2.0% and one study (O'Neill et al., 1973) found that 8% of physically abused children suffer serious abdominal injury, with 40-50% mortality (Cooper et al., 1988; McCort & Vaudagna, 1964; Sivit, Taylor & Eichelberger, 1989; Touloukian, 1968). Abdominal injuries are second only to head injuries in causing death in inflicted childhood trauma (Cooper, 1992; Ledbetter et al., 1988). Inflicted trauma accounts for 1-11% of all presentations of abdominal trauma in childhood injury (Cywes et al., 1990; Gornall et al., 1972; Ledbetter et al., 1988). Pediatricians practicing in the field of child maltreatment need to know how to discriminate reliably between inflicted and accidental abdominal trauma.

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The high mortality rate in cases of inflicted abdominal trauma is due to a variety of factors. Perpetrators are usually aware that the child is injured but fail to seek prompt medical attention because of fear of self-incrimination or lack of understanding of the seriousness of the injury. While caretakers are waiting, watching, and hoping for improvement, deterioration to a critical state may result, such as severe peritonitis and septic shock secondary to intestinal perforation or hemorrhagic shock secondary to liver laceration. Further delay in diagnosis occurs because inaccurate or misleading histories are provided. The history is often the most important component guiding the physician in planning investigation and treatment. When historical information is absent or unclear, a high index of suspicion is required. Children who suffer abdominal injuries are often preverbal (24 months +/- 12 months) (Cooper et al., 1988) limiting additional information collection. Older children may be too ill or fearful of further injury if they speak of the incident.

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Mortality rates are also high because of unique anatomical and physiologic features of children. A child's abdomen is relatively small, with the organs in close proximity. A single abdominal blow may injure more than one organ, with greater consequences than in an adult. The abdominal wall offers limited protection from external trauma because the muscles are less developed and only a small layer of fat is present. The ribs are flexible, with the lower rib cage only covering a small portion of the upper abdomen because of the widely spread costal margins. Finally, significant difficulties may occur from hemorrhagic injuries because of smaller blood volumes and the proportionately larger size of pediatric organs (Cooper, 1992).

Blunt abdominal injuries result when forces are produced (1) from direct blows, such as a punch or a kick, or (2) from indirect shearing forces generated during rapid deceleration of the body, as when a child is thrown across a room. Direct blows crush organs against the immobile vertebral column or the lower rib cage with resultant laceration and hemorrhage. The hollow visceral organs (the stomach and intestine) are filled with food, liquid, air, or stool. A direct blow compresses the contents, leading to sudden overdistension with rupture spilling the contents into the abdominal cavity. With rapid deceleration of the body, internal partially mobile organs continue in motion with resultant tearing of the intestinal mesentery (Haller, 1966).

When evaluating abusive injuries, questions arise about the amount of force required to produce the injury and the means by which this force was applied. A description of accidental forces required to cause similar injuries is helpful. The literature on accidental abdominal injuries suggests that significant violent force is required to cause a life-threatening abdominal injury.

In a South African study of 732 abdominal organ injuries, motor vehicle accidents accounted for 85% of the accidental injuries (88% motor vehicle/pedestrian accidents, 11.5% passengers, 0.5% cyclists), while falls from a height accounted for 12.5%, and sporting injuries accounted for most of the remainder (Cywes et al., 1990). A Seattle study of 139 accidental abdominal organ injuries in children found motor vehicle accidents accounted for 70% of the accidental injuries (57% pedestrians, 17% passengers, 20% cyclists, 6% motorcycle passengers), while falls accounted for 20%, followed by a number of other causes (contact sports, struck by a falling object, and being kicked by a farm animal) (Ledbetter et al., 1988). These accidental injuries in the Seattle study were described as high-velocity incidents with frequent coexistence of major associated injuries. Much of the 21% mortality in the accidentally injured children resulted from associated head injuries, with only two of the seven deaths in that group having isolated abdominal injury. In contrast, 53% mortality was present in the comparison group of 17 abused children, with eight of the nine who died having isolated abdominal injuries.

An additional study of children with abdominal injuries found four deaths, all with associated severe cranial or thoracic injuries, in a group of 69 accidentally injured children. In comparison, two of six abused children died with isolated abdominal

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injuries (Gornall et al., 1972). These studies illustrate that even with the degree of force generated in a high velocity motor vehicle accident, it is rare to see the death of a child from isolated abdominal injury. For an abdominal injury to cause death, a great deal of force must be applied specifically to the abdominal region.

Presentation of abusive vs. accidental injuries

In abusive abdominal injuries, common explanations for the child's condition include children falling (from bed, down stairs, from the couch), cessation of breathing, vomiting, trivial episodes of head trauma or no explanation (Cooper et al., 1988; Ledbetter et al., 1988). Presenting symptoms vary with the different organs involved; symptoms suggestive of individual organ damage will be discussed below. Boy victims outnumber girl victims, and the children are frequently about two years of age (accidentally injured children tend to be older, around 7.5 years of age). Major associated injuries are infrequent, whereas injury patterns typically seen in child abuse are often observed (65% of cases) (Ledbetter et al., 1988), such as occult skeletal injury, evidence of past burns or multiple bruises of different ages in different locations. Bruising of the abdominal wall is not a typical finding because the majority of the force resulting from abdominal blows is transmitted to the intra-abdominal organs.

In accidental abdominal trauma, single solid organ injuries are more frequently observed, whereas in abusive injuries hollow viscus injuries are more common, although overlap exists between the two. The kidney, spleen, and liver are the most frequently injured in accidents. In contrast, kidney and spleen injuries are infrequent in inflicted trauma, with the liver being the most common solid organ injured. Hollow viscus injuries are the most common finding in abuse, with the majority occurring in the proximal small intestine (the duodenum and the jejunum). Pancreatic and mesenteric injury are occasionally seen. Improved imaging studies coupled with increased awareness has shown that non-fatal abusive abdominal injuries may be more common than previously reported and at times asymptomatic (Coant et al., 1992; Hennes et al., 1990; Sivit, Taylor & Eichelberger, 1989). This is consistent with the discovery of other occult injuries as one of the classical findings in child abuse.

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Hollow viscus injury

Rupture of the stomach from abusive trauma has been reported (McCort & Vaudagna, 1964). Gastric rupture is more likely to occur in children who suffer direct blows soon after a large meal. The children present in serious condition and plain abdominal radiographs reveal substantial free intraperitoneal air. Immediate operative treatment is required.

Intestinal injuries are relatively common in children who suffer abusive injuries to the abdomen. The small intestine is the most common location for these injuries (Gornall et al., 1972; Ledbetter et al., 1988; McCort & Vaudagna, 1964). Perforations of the small intestine are seen most often in the jejunum (60%) with 30% in the duodenum and 10% in the ileum (Kleinman, 1987). The frequent finding of damage in the duodenum and the jejunum typically close to the Ligament of Trietz suggests that the proximal small intestine is more susceptible to compression injury because of its fixed location. Deceleration forces or direct local traumatic blows are likely responsible for intestinal injuries in those portions suspended by mesentery. Tearing of the mesenteric attachment may occur with hemorrhage from the contained vessels. Abnormal intestinal fixations such as postoperative adhesions may predispose for injury (Schimpl, Schmidt & Sauer, 1992).

The signs of intestinal perforation in a child are frequently subtle, with a variable delay in the appearance of symptoms (Fossum & Descheneaux, 1991; Ramenofsky, 1987). Mild abdominal tenderness may be the only initial sign, although fever, vomiting, abdominal distention, diminished bowel sounds and peritoneal signs may be observed. Pneumoperitoneum is seen on plain radiographs of the abdomen only in a minority of children with intestinal perforations (Brown et al., 1992; Bulas, Taylor & Eichelberger, 1989) because early sealing of the perforation may occur. If the patient is clinically stable, the most sensitive radiographic view to detect pneumoperitoneum is an upright chest film. A left lateral decubitus is next in sensitivity, followed by an upright abdominal view. CT scan may assist in establishing the diagnosis, although false negative examinations do occur (Bulas, Taylor & Eichelberger, 1989; Schimpl, Schmidt & Sauer, 1992). Discovery of intraperitoneal fluid on CT scan in cases of suspected abdominal trauma without evidence of other injury is suggestive of a sealed hollow viscus perforation. The most reliable indicator of perforation is repeated clinical examinations looking for the development of peritoneal irritation. Typically, abdominal signs will develop within hours.

Intramural hematomata of the intestine are frequently the result of inflicted abdominal injuries. Without definite history of blunt trauma to the upper abdomen, duodenal hematomata are highly suspicious for child abuse. Located in a fixed position close to the vertebral column, the duodenum is susceptible to crushing injuries with resultant intramural hematoma (Woolley, Mahour & Sloan, 1978). Blood leaks from the abundant vasculature between the layers of the wall, producing an intramural

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hematoma which encroaches into the intestinal lumen with variable degrees of obstruction.

The clinical picture is one of vomiting, often bilious vomiting (dehydration may occur), abdominal pain, and tenderness without other observable abnormality. Appearance of symptoms is typically delayed following the injury with delays of 1 hour to 2.5 days reported (Pokorny, Brandt & Harberg, 1986; Woolley, Mahour & Sloan, 1978). Abdominal bruising and masses are infrequent. Blood loss may be significant. Coagulation defects should be considered. Because of the close association of the pancreas with the duodenum, concurrent injury is not uncommon and blood and urinary amylase levels should be measured.

The literature on accidental abdominal injuries suggests that significant violent force is required to cause a life-threatening abdominal injury.

Plain films of the abdomen will frequently be normal, although significant dilation of the stomach may be observed. Upper GI (gastrointestinal) series is the gold standard for diagnosis. A large smooth rounded intramural mass in the lateral wall of the duodenum encroaching on the lumen is typically outlined by the contrast material (Kleinman, 1987). With passage of contrast material a "coiled spring" appearance is frequently seen. This results from trapping of contrast material in the mucosal folds adjacent to the hematoma. Ultrasound (Orel et al., 1988) and CT scans may demonstrate an intramural hematoma but an upper GI series should be done for confirmation. Kleinman has documented characteristic radiological features which may persist following symptomatic improvement in children with duodenal hematoma. He recommends completion of an upper GI series in children who were suspected to have abusive abdominal injury despite symptom resolution (Kleinman, Brill & Winchester, 1986).

Hematoma of the intestine distal to the Ligament of Trietz are typically located at the mesenteric borders frequently with accompanying mesenteric hemorrhage.

Pancreatic injuries

Pancreatitis in children is unusual and should raise the question of trauma (Slovis et al., 1975). Because the organ is deeply situated in the abdomen, injury is uncommon, although its fixed position immediately anterior to the vertebral column makes it susceptible to deep crushing injuries. Isolated accidental pancreatic injuries have been reported following falls onto small objects such as bicycle handlebars (Dahman & Stephens, 1981; Sparnon & Ford, 1986; Young & Adams, 1967). A review of 27 cases of children suffering abdominal injuries after being accidentally run over by cars revealed elevation of serum amylase in only one (Chadwick, Merten & Reece, 1994), indicating the level of force required to cause traumatic pancreatic injury. Frequently, other organs in the proximity are injured and evaluation of these should also be undertaken.

Pancreatitis occurs following tissue injury with release of pancreatic enzymes. These enzymes digest the organ with resultant hemorrhage and edema. Severe pancreatic trauma may result in complete transection of a portion of the organ (Cooper, 1992; Grosfeld & Cooney, 1975). Medical causes of pancreatitis should be considered, including gallstones, hyperlipidemia, hypercalcemia, viral infections, and medication reactions (Cooney & Grosfeld, 1975; Hartley, 1967).

Clinically, abdominal pain, vomiting, and fever are seen. These symptoms may gradually develop after the injury, leading to occasional delay in presentation. Epigastric tenderness with an accompanying abdominal mass may be found. Serum and urine amylase levels are significantly elevated. With severe traumatic transections chemical peritonitis may result with serious clinical implications.

Pancreatic pseudocysts are collections of pancreatic juice in and around the pancreas which are confined by non-epithelialized capsules of fibrous and granulation tissue. Most pseudocysts in the pediatric age group arise after blunt trauma to the abdomen (Burnweit et al., 1990; Cooney & Grosfeld, 1975; Kilman et al., 1964; Pena & Medovy, 1973; Pokorny, Raffensperger & Harberg, 1980). Abdominal pain, fever, vomiting, elevation of the urinary and serum amylase levels, and the presence of an abdominal mass are the presenting clinical features. The time interval between injury and diagnosis varies between 6 days and 16 weeks (Cooney & Grosfeld, 1975; Pokorny, Raffensperger & Harberg, 1980; Sparnon & Ford, 1986).

In acute pancreatitis, ultrasound often reveals enlargement of the gland owing to edema (Kleinman, 1987). Ultrasound allows noninvasive repetitive evaluation of pancreatic size and early diagnosis of pseudocyst formation (Kleinman, 1987; Slovis, VonBerg & Mikelic, 1980). Spontaneous resolution of pseudocysts occurs and is well documented with ultrasound (Burnweit et al., 1990; Slovis, VonBerg & Mikelic, 1980). Computed tomography of the abdomen clearly delineates the pancreas and any accompanying pseudocysts. Advantages of ultrasound in abdominal imaging are the lower cost, the mobility, and the lack of radiation (Kleinman, 1987; Luks et al., 1993). Disadvantages of use in imaging of the upper abdomen include interference of the image by ribs, intestinal gas, and air in the stomach (Kane et al., 1988; Kaufman et al., 1984; Slovis, VonBerg & Mikelic, 1980).

Liver injuries

The liver is the most commonly injured solid organ in cases of inflicted abdominal trauma (Coant et al., 1992; Cooper, 1992). The organ is injured by a direct crushing blow, although decelerating injuries

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also occur. Lacerations of the liver parenchyma result from direct trauma with resultant hemorrhage. Decelerating injuries may result in damage to areas of ligamentous attachment with vascular disruption. Vascular injury and significant parenchymal lacerations may lead to serious blood loss and death prior to hospital arrival. As previously noted the child's clinical condition may be further compromised by delay in seeking medical attention. Intrahepatic and subcapsular hematoma are often small and may result in little blood loss (Bass et al, 1984). Bile duct injury has been reported (Gornall et al. 1972; Oldham et al., 1986). In accidental abdominal injuries the right lobe is frequently injured in contrast to the frequent left lobe injury in abusive trauma (Coant et al., 1992). This finding likely represents trauma from anterior abusive blows. Mild hepatic injuries may heal within one week, while more severe hepatic injuries may continue healing for many months (Bulas et al., 1993).

In cases of serious liver injury the child will present in shock with marked intraperitoneal bleeding. Abdominal distention may be found as well as decreased or absent bowel sounds. Pain in the upper right abdomen coupled with tender enlargement of the liver may be observed if the child is conscious without other significant intra-abdominal injury. Minor liver injuries may remain asymptomatic (Bulas et al., 1993; Coant et al., 1992; Cooper, 1992; Sivit, Taylor & Eichelberger, 1989).

Evaluation of liver function tests as predictors of liver injuries has been done for three reasons: 1. physical examinations are often unreliable in children with multiple injuries, and in the unconscious child, 2. less severe liver injuries are often unsuspected on clinical grounds, 3. biochemical testing is cheaper and readily available as compared with CT scans (Coant et al, 1992; Hennes et al, 1990; Oldham et al., 1986). In one study of 53 children who had suffered blunt liver injury, elevations of SGOT (AST) greater than 200 IU coupled with SGPT (ALT) levels greater than 100 IU resulted in a 61% probability of discovering a liver injury by CT scan. No children with liver enzymes below these levels had demonstrable liver injury (Oldham et al., 1986). Alkaline phosphatase levels are often normal in cases of blunt liver trauma (Cywes, Rode & Millar, 1985). Another study of 43 hemodynamically stable children with blunt abdominal trauma revealed that SGOT levels greater than 450 IU coupled with SGPT levels greater than 250 IU identified all of the patients with hepatic injury detected on CT scan (Hennes et al, 1990). Two patients had elevations without CT scan evidence of hepatic injury. Finally, liver function tests were collected from 49 cases of suspected child abuse who did not have clinical signs of abdominal injury. Four of the children had elevated liver transaminases with CT scan confirmation of liver injury present in three patients (6% of the total sample) (Coant et al, 1992). Only one of the four had elevation of the alkaline phosphatase. The elevation of the transaminases appears transient, with normalization within days. Use of enzymes may therefore be useful adjuncts in evaluation of the physically abused child both with and without suspicion of abdominal injury.

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Plain abdominal radiographs may demonstrate gross abnormalities in the liver size and shape as well as rib fractures. Computed tomography is the most sensitive non invasive technique to assess for hepatic injury (Kleinman, 1987). Advantages include: 1. superior anatomic detail, 2. the ability to survey the entire abdomen and retroperitoneum, 3. the ability to detect small amounts of intraperitoneal blood or gas, 4. the ability clearly to visualize bony abnormalities, and 5. the ability to assess vascular integrity of intra-abdominal organs with contrast enhancement (Kane et al., 1988; Kaufman et al., 1984). Scintigraphy in the form of liver-spleen scanning was previously used to assess for injury but anatomical detail is poor (Kane et al., 1988; Kleinman, 1987). Ultrasound may identify hepatic hematoma but often misses small lacerations, although it has proven useful in following progression of liver lesions (Cywes, Rode & Millar, 1985; Kleinman, 1987).

Kidney and spleen injuries

The kidneys are the second most commonly injured solid organ in abusive abdominal trauma. These likely result from direct blows to the flanks as well as decelerating forces (Cooper, 1992). Injury may be 1. minor, such as local contusions or intracapsular lacerations, 2. major, with parenchymal damage and capsular tearing or parenchymal lacerations with extension into the collecting system, and 3. critical, involving fragmentation of the kidney or vessel damage (Kirks, 1983). Children may present with flank pain and tenderness with an accompanying mass and external bruising. Hematuria is generally present in cases of renal trauma and the quantity of blood may be predictive of the seriousness of injury (Stalker, Kaufman & Stedje, 1990).

CT scans reveal the range of renal abnormalities, delineating the extent of parenchymal damage, perirenal hematoma, extravasation of urine and renal vascular damage. Ultrasound and intravenous pyelography also have a role in imaging of renal injuries.

Splenic injuries, while common in accidental abdominal injuries, are uncommon in abusive injuries. Left upper quadrant pain and tenderness will likely be present often accompanied by left shoulder referred pain. Plain films may document rib frac-

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tures, and displacement of the stomach medially. CT scanning of the abdomen typically delineates splenic injury.

Conclusion

In summary, inflicted abdominal injuries in children, while infrequent, have significant morbidity and mortality. Because children with abdominal injuries have variable and sometimes subtle symptoms, a lack of external markings, and a false or misleading history, a high index of suspicion must exist to diagnose these injuries correctly. Computed tomography provides excellent detailed images of the abdominal organs generally demonstrating the majority of injuries. Difficulty in diagnosis occurs in cases of hollow viscus organ injuries. Diagnosis of inflicted childhood abdominal injuries is important both from a medical perspective and one of child protection

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