Pancreatic Trauma in Children and Its Early Diagnosis

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Blunt pancreatic injury (BPI) is relatively uncommon in children, and is associated with relatively high morbidity and mortality, especially if diagnosis is delayed. Blunt trauma represents the primary cause of pancreatic injury in the pediatric population. Pancreatic trauma in children remains a major challenge for emergency physicians as well as general and pediatric surgeons. Its rate of occurrence is 0.2–2%, and it contributes to 0.3% of all childhood injuries.

Keywords: pancreatic trauma ; children ; diagnosis ; treatment ; imaging ; ultrasonography (US)

1. Blunt Pancreatic Trauma in Children—General

The mortality rate associated with BPI remains low, ranging between 4.7–5.3%, with most fatalities linked to concurrent injuries. While there are established protocols for diagnosing and surgically managing pancreatic injuries in adults, the approaches to handling high-grade BPI involving the major pancreatic duct in children remain a subject of debate. In 2022, The Western Trauma Association (WTA) published clinical practice guidelines on pancreatic trauma in the adult population [1]. The WTA evaluation and management algorithm applies to the diagnosis and management of adult patients with BPI. Since delayed diagnoses can result in increased morbidity and mortality of up to 62% of patients [1], the WTA Committee recommends early performance of CT as part of the initial trauma workup. Imaging findings of transection of the pancreas, disruption of the MPD, or of a large amount of peripancreatic fluid mandate operative exploration. When imaging findings are not sufficiently clear-cut, other investigations may be useful, and they include serial abdominal examinations, serum amylase and lipase enzyme levels, MRCP, endoscopic retrograde cholangiopancreatography (ERCP), and transduodenal pancreatography. The major determinant in management decisions in adults with BPI is the presence or absence of injury to the main pancreatic duct (MPD). Since low-grade pancreatic trauma (Grades I and II) are contusions and lacerations that spare the pancreatic duct, they are mostly managed conservatively. In adult patients with low-grade injuries who have indications for laparotomy, drain placement to control the leakage is recommended only if there is pancreatic capsule disruption. In accord with the WTA algorithm, most adults with “high-grade” pancreatic injuries (Grades III = MPD injury to the left of the superior mesenteric vein [SMV], Grade IV = MPD injuries to the right of the SMV, and Grade V = involving disruption of the head of the pancreas) require definitive surgical treatment to avoid duct-related complications that carry a morbidity of up to 60% [1].

There are no clear-cut guidelines for the initial management of BPI in children among whom the diagnosis, classification, and treatment remains a challenge. Non-operative management of ISO injuries in stable children is also pertinent to the management of BPI. The BPI we report in a six-year-old girl, which manifested with unclear clinical presentations of an MPD injury, resulted in delayed diagnosis and surgical intervention. During her operation, spleen-sparing surgery was not feasible, and she underwent a distal pancreatectomy and splenectomy. Postoperatively, she developed a pancreatic fistula that was treated by external catheter drainage and required total parenteral nutrition (TPN) for two weeks, and repeat administration of Sandostatin. The percutaneous pancreatic fistula drain was removed one month later, and the fistula closed spontaneously. The child’s outcome was ultimately favorable, with no recurrence of symptoms during the 12-month follow-up period.

2. Early Diagnosis—Pitfalls

Early diagnosis of pancreatic trauma is key to optimal management, but it remains a challenge even with more advanced imaging modalities. Traumatic BPIs are associated with high morbidity and mortality rates in both adults and children, making it crucial to minimize time for diagnosis and appropriate intervention. Due to its protected retroperitoneal location, injuries of the pancreas are uncommon in children and are often misinterpreted. The symptoms and physical signs of BPI in children may be nonspecific or even absent, and are frequently overlooked for not being readily apparent on initial examination. Additionally, abdominal symptoms such as abdominal pain, nausea, and vomiting do not always correlate with trauma severity.

Table 1 summarizes a current (the past 5 years) literature review of publications on the early diagnostic tools during initial management in children with BPI.

Table 1. The summary of previous literature regarding early diagnostics of pancreatic injury in children.

Authors/ Year	Number Patients (Mean Age/y)	Serum Amylase (No Pts/PV%)	Serum Lipase (No Pts/PV%)	US (No Pts/PV%)	CT (No Pts/PV%)	MRI (No Pts/PV%)	ERCP (No Pts/PV%)
Zhang et al. (2023) [2]	51 (7.3)	LGI—81% HGI—100%	LGI—53% HGI—100%	50 68%	45 77%	11 100%	0
Catellani et al. (2023) [3]	10 ad (28.2) 20 chld (10.5)	10 49%	N/A	N/A	10 90%	N/A 100%	N/A 100%
Gong et al. (2023) [4]	31 (11.7)	N/A	N/A	16 N/A	29 61%	N/A	15 86%
Everson et al. (2023) [5]	19 (13)	N/A	19 74%	1 N/A	19 79%	3 N/A	0
Goldberg-Murow et al. (2021) [6]	11 (9)	11 60%	N/A	FAST 11/ NA	11 90%	1 100%	0
Ibrahim et al. (2021) [7]	28 (7.14)	N/A	N/A	N/A	27/ 93%	10 100%	0
Rosenfeld et al. (2018) [8]	21 (7.8)	N/A	N/A	N/A	21 38%	NA 62%	0
Wiik-Larsen et al. (2020) [9]	10 (8.3)	9 67%	N/A	N/A	9 67%	3 100%	0

Abbreviations: Pts—patients, LGI—low grade injury, HGI—high grade injury, Pts—patients, PV—predictive values, N/A—not applicable; FAST—focused assessment with sonography in trauma; CT—Computed tomography, US—ultrasonography, MRI—Magnetic resonance imaging, ERCP—endoscopic retrograde cholangiopancreatography.

Ultrasonography (US) is commonly used to detect intra-abdominal organ injury. It is commonly available in emergency rooms, and the imaging study is routinely part of the initial assessment of children with blunt abdominal trauma. US may serve as a good rapid screening procedure, particularly in patients too unstable to undergo an abdominal CT scan. However, US is limited by its low sensitivity and specificity when determining acute pancreatic injuries. The reported sensitivities for the detection of pancreatic injuries by US ranged from 27% to 96% [10]. Zhang et al. reported a 68% accuracy rate for detecting pancreatic injury in 51 children by early US (**Table 1**) [2]. Ultrasound imaging, however, cannot provide valuable information regarding the size, location, and characteristics of BPIs [8].

The WTA Committee recommends early CT as part of an initial pancreatic trauma workup in adults [1]. CT scanning has been the diagnostic imaging method of choice to detect BPI in adult and children for more than three decades. It is highly accurate in diagnosing pancreatic damage, thereby lowering the rate of missed or delayed diagnoses of BPI, leading to decreased morbidity and mortality, and serving as an important factor in determining the need for surgical treatment. However, several studies have reported low sensitivity of CT ranging from 38% to 61% for diagnosing MPD injuries in children [1][2][3][8][9][10][11][12][13][14][15][16] (**Table 1**). Recent advancements in technology (multidetector CT technology [MDCT]) have enabled improved detection of these injuries. Phelan et al. reviewed the findings of 16-MDCT and 64-MDCT studies from 22 centers (206 pediatric patients with BPI) and compared them to the operative findings. Those researchers reported that the sensitivity for MPD injury was 54% for 16-MDCT and 52% for 64-MDCT, although the specificity was higher (95% and 90%, respectively) [16]. In addition, they observed that the overuse of CT in blunt abdominal trauma in children leads to inefficient care and radiation-induced malignancies. Therefore, to maximize precision and minimize the overuse of CT, several professional societies and organizations proposed clinical prediction rules for determining the use of radiographic imaging after traumatic injuries [17].

MRCP is a useful alternative diagnostic modality thanks to it lacking the need for ionizing radiation, its panoramicity, its affording the possibility to avoid the use of contrast media, and its ability to properly evaluate even small pancreatic ductal disruptions. MRCP is also highly sensitive in distinguishing between different types of BPI. Rosenfeld et al. recently compared the accuracy of CT and MRCP for identification of MPD disruption in BPI in children (**Table 1**) [8]. Data were obtained from eleven pediatric trauma centers. The results of this study showed that MPD visualization and duct disruption were visualized more often on MRCP than on CT, but the overall MRCP score (duct visibility, duct disruption,

pancreatic parenchymal injury, and secondary findings [e.g., peri-pancreatic fluid collections and free intraperitoneal fluid]) for determining duct integrity was not better than that of CT (38% vs. 62%, respectively, *p* = NS). In a large series by Zhang et al. (51 children with BPI), 46 patients (90.2%) underwent abdominal CT, 31 patients (60.8%) underwent enhanced CT, and 12 patients (23.5%) underwent MRCP. Those researchers reported a 77% accuracy rate for CT and a 100% accuracy rate for MRCP in identifying MPD damage [2]. Ibrahim et al. recently presented their experience with CT and MRI in pediatric pancreatic trauma and correlated the imaging grade of pancreatic injury with management and outcome. Those researchers reported a 93% accuracy for CT (27 patients) and a 100% accuracy for MRCP (10 patients) [7].

During the last decade, contrast-enhanced ultrasound (CEUS) has been considered an appealing alternative to contrast-enhanced CT in the evaluation of children with blunt abdominal trauma, mainly with respect to the potential reduction in the use of ionizing radiation and contrast media [18]. Pancreatic lacerations and fractures appear on CEUS as non-enhancing or hypoenhancing defects in both the arterial and venous phases of enhancement, and are frequently seen to involve the pancreatic capsule [5]. However, CEUS has some limitations, particularly in the assessment of small pancreatic lesions, in the evaluation of mild ductal disruptions, and in the detection of vascular complications. In a recent comparative study, Miele et al. compared the usefulness and the feasibility of MRI and CEUS in the follow-up of patients with low-grade blunt abdominal trauma. Those researchers showed that MRI enabled a better assessment of injuries than CEUS while also allowing the determination of the temporal stage of the lesions [19].

The specificity of ERCP in the identification of MPD disruption is very high in most cases, and it has the added benefit of guiding therapeutic intervention. However, the invasive nature of ERCP and the lack of widespread availability for the pediatric population at many institutions limit its utility. Additionally, ERCP does not allow for evaluation of the pancreatic parenchyma and surrounding tissue damage, nor can it detect pancreatic duct disruption distal to an obstruction. In a recent trial, Gong et al. [4] discussed the usefulness and safety of ERCP in traumatic pancreatic injury in children, 48% of whom had BPI and underwent ERCP. Those researchers concluded that ERCP was indicated for both diagnostic purposes since imaging findings on CT and US are not as clear-cut as therapeutic purposes after pancreatic duct injury had been identified on radiologic imaging. ERCP was performed for therapeutic purposes in four of their patients. Those researchers showed that the diagnostic accuracy of radiologic injury grade (correlating to the final injury grade) was about 61%, while ERCP had a diagnostic accuracy rate of 86%. They concluded that ERCP can be usefully and safely performed in children with BPI for both diagnostic and therapeutic purposes.

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