Blunt Pancreatic Trauma in Children: CT Diagnosis

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The purpose of this study is to determine the efficacy of CT in the diagnosis of pancreatic injury after blunt abdominal trauma in children. Pancreatic injury was diagnosed at surgery, at autopsy, or on the basis of the development of clinical pancreatitis or a pseudocyst on follow-up imaging evaluation in 18 of 1045 consecutive children examined with CT after blunt trauma. Types of pancreatic injury included laceration in 11 children, transection in two, contusion in one, and tumor with hemorrhage in one. Three children had clinical pancreatitis without a pancreatic abnormality noted on CT. The pancreatic injury was prospectively identified on CT in 12 children (67%). The presence of fluid in the lesser sac was a useful marker for injury to the pancreas. This was noted in 13 children with pancreatic injury, whereas it was observed in only six (1%) of 1028 children in the absence of pancreatic injury (sensitivity, 72%; specificity, 99%). Fluid in the anterior pararenal space was less helpful in establishing the diagnosis of pancreatic injury (sensitivity, 44%; specificity, 98%). A pancreatic pseudocyst developed in four of the 11 survivors.

Our experience shows that direct signs of pancreatic trauma may be difficult to identify on CT. Recognition of the limitations of CT diagnosis of pancreatic injury is important in helping to reduce errors of interpretation.

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CT has replaced peritoneal lavage as the method of choice in evaluating children with suspected abdominal injury after blunt trauma and has proved to be accurate in the detection and delineation of hepatic, splenic, and renal injuries [1–3]. Pancreatic injuries have proved more difficult to identify with CT [4–6]. Because pancreatic trauma is rare in children, experience regarding acute imaging findings is limited [7–9]. In this report, we analyzed data from 1045 consecutive cases of blunt trauma to determine the accuracy of CT in evaluating blunt pancreatic injury.

Subjects and Methods

Between January 1983 and June 1991, 1045 children who sustained blunt trauma and who clinically were presumed to have injury to intraabdominal organs were prospectively evaluated with abdominal CT at our institution. Pancreatic injury was diagnosed at surgery in 10 children, at autopsy in five children, and at clinical or imaging follow-up in three children. The latter group included two children who did not have laparotomy and showed a pancreatic pseudocyst on follow-up imaging examination and one additional child who did not have laparotomy and in whom clinical pancreatitis developed. Pancreatitis was defined as persistent elevation of serum amylase levels above 100 IU/l for more than 3 days [10].

Demographic data, indications for CT, and Trauma Score [10, 11] were recorded for all children at the time of admission. Injury Severity Score was recorded at the time of discharge or death [12]. Radiologic findings were recorded at the time of initial interpretation. Clinical records were reviewed to determine the type of management (operative or nonoperative), serum amylase values, and clinical outcome.

Thirteen children were male and five were female (age range, 2–13 years; mean age,

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7 years). The mechanisms of injury included 11 motor vehicle–related injuries: seven of the children were pedestrians and four were passengers. Three were bicyclists, two were assaulted, one was struck while wrestling with a friend, and one fell. The median Trauma Score in these children was 3 (range, 3–16). The median Injury Severity Score was 15 (range, 5–57).

Indications for CT included abdominal tenderness (12 children), abrasions or ecchymosis (11 children), absent bowel sounds (nine children), hematuria (nine children), neurologic obtundation (nine children), abdominal distension (eight children), low hematocrit (seven children), vomiting (three children), and fractured pelvis (one child).

CT was performed on a GE 9800 CT scanner (GE Medical Systems, Milwaukee, WI) with 1-cm-thick sections obtained at 1-cm intervals through the abdomen and pelvis. Three milliliters per kilogram (maximum dose, 120 ml) of IV contrast material (iothalamate meglumine, Conray 43; Mallinckrodt, St. Louis, MO, or iohexol, Omnipaque 240, Winthrop, New York, NY) was administered by means of rapid bolus injection to opacify the solid abdominal viscera. Oral contrast material was not used during the initial CT scan. In three of these children, however, CT examination was repeated after the administration of oral contrast medium 10–60 min before scanning, because of a strong clinical suspicion of pancreatic injury.

Results

The types of pancreatic injury included laceration in 11 cases (Fig. 1), transection in two (Fig. 2), contusion in one, and tumor with hemorrhage in one (Fig. 3). Three additional children had clinical pancreatitis. The anatomic distribution of 14 pancreatic transections, lacerations, and contusions was as follows: injury limited to the pancreatic body in nine, limited to the pancreatic tail in two, limited to the pancreatic head in one, head and body combined in one, and body and tail combined in one.

CT Findings

The pancreatic injury was identified on CT scans in 12 children (67%). Three children who had a normal-appearing pancreas on CT had a pancreatic injury noted at laparotomy or autopsy (laceration in two, contusion in one). Two children who had a normal-appearing pancreas on CT and at laparotomy had postoperative pancreatitis. One additional child who had a normal-appearing pancreas on CT did not undergo laparotomy but subsequently had clinical pancreatitis.

Peripancreatic fluid collections on CT were noted in 13 children (72%) who had pancreatic injury. The fluid was in the lesser sac in all 13 children (72%), in the anterior pararenal space in eight (44%), and in the posterior pararenal space in one (6%) (Fig. 4). The location of fluid in the anterior pararenal space was bilateral in five cases and limited to the left side in three cases. Thickening of Gerota's fascia was seen in all seven children who had fluid in the anterior pararenal space. Fluid in the anterior pararenal space was always associated with fluid in the lesser sac. Peripancreatic fluid was observed in one of three children who subsequently had clinical pancreatitis.

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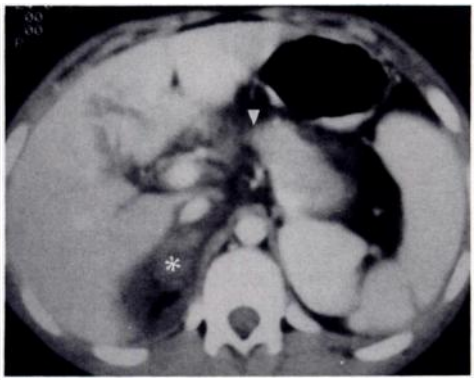

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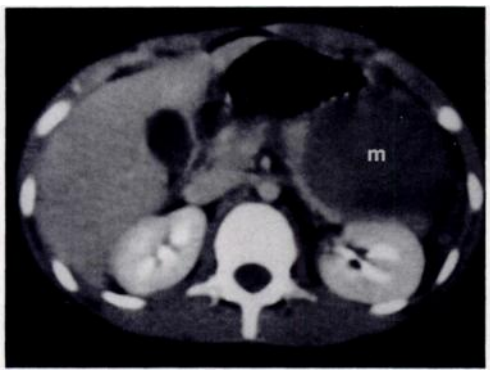
Fig. 1.—Pancreatic laceration with minimal separation of fracture fragments in a 5-year-old boy who was run over by a car. CT scan shows linear area of low attenuation (*arrowheads*) in pancreatic body.

Fig. 2.—Pancreatic transection with nonenhancement of head of pancreas in a 10-year-old girl injured in a motor vehicle crash. CT scan at level of pancreas shows a transection through pancreatic body (*arrowhead*) with absence of contrast enhancement of pancreatic head. Note hepatic laceration and right adrenal hematoma (*asterisk*).



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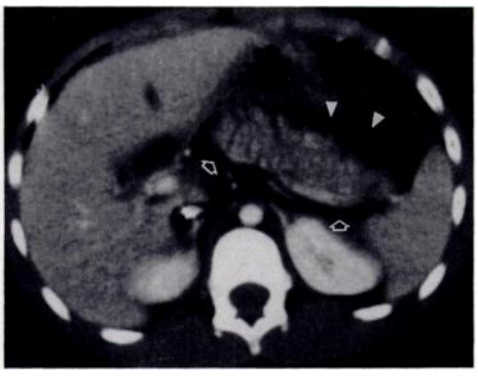

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Fig. 3.—Pancreatic tumor with hemorrhage in a 13-year-old girl injured while wrestling. CT scan at level of pancreas shows a large pancreatic mass (m) extending anteriorly into lesser sac.

Fig. 4.—Peripancreatic fluid collections associated with pancreatic injury in a 6-year-old boy run over by an automobile. CT scan of upper abdomen shows fluid in lesser sac (*arrowheads*) and anterior pararenal space (*arrows*). Pancreas appeared normal on CT. A pancreatic laceration was noted at surgery.

Fluid in the lesser sac was observed in six (1%) of 1028 children without pancreatic injury who sustained blunt trauma and were studied with CT (Table 1; specificity for pancreatic injury, 99%). Similarly, fluid in the anterior pararenal space was seen in 18 (2%) of 1028 children without pancreatic injury studied with CT (Table 2; specificity for pancreatic injury, 98%). Fluid in the lesser sac and anterior pararenal space was observed in three children with a normal pancreas on CT and a pancreatic injury (laceration in two, contusion in one) noted at laparotomy or autopsy (Fig. 4).

Associated Injury

Six children (33%) had associated intraabdominal injuries. These included four hepatic, three bowel, three splenic, and one renal injury. In addition, dilated fluid-filled bowel loops with intense enhancement of bowel wall, mesentery, and kidneys and decreased caliber of the abdominal aorta and inferior vena cava consistent with the "hypoperfusion" complex were noted in four children [13].

Outcome

Ten children (56%) underwent surgical exploration. Of these, eight required laparotomy on an urgent basis. One had elective resection of a papillary cystic tumor of the pancreas, and one underwent drainage of a pseudocyst. Disruption of the main pancreatic duct was noted in six children who underwent surgical exploration. All six of these children had fluid in the lesser sac on the initial CT examination.

Seven children (39%) died. Of 11 survivors with pancreatic injury, five had subsequent CT or sonographic examinations 6–12 days after the injury. Indications for follow-up examinations included persistent elevation of serum amylase levels (three children), abdominal pain (two children), and fever (one child). A pancreatic pseudocyst was noted on follow-up examination in four children (lesser sac in three, intrapancreatic in one; Fig. 5). All four had a pancreatic laceration noted on the initial CT scan. Peripancreatic fluid (lesser sac in two, anterior pararenal space in one) had been noted on the initial CT examination in two of these children.

TABLE 1: Abnormalities Associated with Fluid in Lesser Sac on CT

Abnormalities	No. (%) of Patients (n = 19)
Pancreatic injury	13 (68)
No pancreatic injury	6 (31)
Isolated bowel injury	1 (5)
Isolated hepatic injury	1 (5)
Isolated hypoperfusion complex	1 (5)
Combined bowel and renal injury	1 (5)
Combined hepatic and splenic injury	1 (5)
Combined splenic and renal injury	1 (5)

TABLE 2: Abnormalities Associated with Fluid in Anterior Pararenal Space on CT

Abnormalities	No. (%) of Patients (n = 26)
Pancreatic injury	8 (31)
No pancreatic injury	18 (69)
Isolated renal injury	3 (12)
Isolated bowel injury	2 (8)
Isolated hepatic injury	2 (8)
Isolated splenic injury	1 (4)
Isolated adrenal hematoma	1 (4)
Isolated hypoperfusion complex	1 (4)
More than one abnormality	7 (27)
No abnormality detected	1 (4)

Discussion

Pancreatic injury after blunt trauma in children is uncommon, and experience with its diagnosis is limited [7–9]. We observed injury to the pancreas in approximately 2% of children who had CT examinations after blunt trauma during an 8-year period. Pancreatic injury accounted for 6% (18/292) of all injuries to solid abdominal viscera seen in these children.

In three of 14 children who had pancreatic laceration, transection, or contusion, the injury was not identified on the initial CT scan. Accurate CT-aided diagnosis of pancreatic injury in children is difficult. Delineation of the margins of the pancreas may be troublesome owing to the smallness of the organ and the relative paucity of surrounding retroperitoneal fat in children. CT signs of pancreatic trauma also may be difficult to identify [4, 5, 8]. Laceration or contusion of the pancreas may produce little change in attenuation in the acute phase of the injury [4, 5]. There may be little separation of fractured pancreatic fragments (Fig. 1) [4]. In addition, it may be difficult to distinguish a laceration in the tail of the pancreas from adjacent unopacified bowel loops.

Evidence of pancreatitis, such as focal or diffuse organ enlargement, contour irregularity, and loss of definition of adjacent fat planes, was not present on CT scans obtained immediately after injury in three children in whom pancreatitis later developed. Two of these children also had a normal-appearing pancreas on gross inspection at laparotomy. Posttraumatic pancreatitis occurs as a consequence of direct blunt force and autodigestion by liberation of pancreatic enzymes

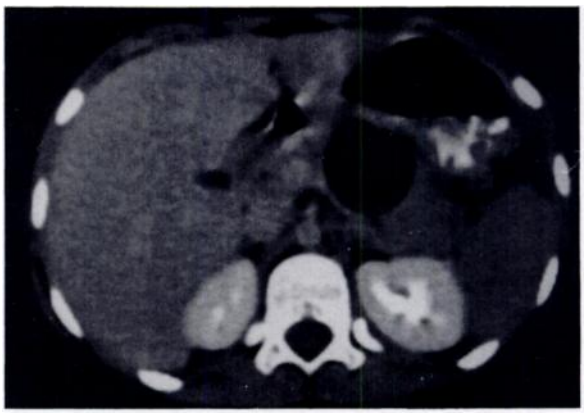

Fig. 5.—Pancreatic pseudocyst in 5-year-old injured in a motor vehicle crash. CT scan 8 days after injury shows a low-attenuation pseudocyst within body of pancreas.

after the injury [14]. As a result, pancreatic inflammatory changes evolve over time [15].

Although administration of oral contrast material for CT examination of the abdomen after blunt trauma is not routine at our institution, CT examination was repeated after the administration of oral contrast medium in three children because of a strong clinical suspicion of pancreatic trauma. Delineation of pancreatic injury in these children was not improved on the contrast-enhanced examination.

The presence of peripancreatic fluid in the absence of abdominal visceral injury should strongly suggest pancreatic injury (Fig. 4). The pancreas is located in the anterior pararenal space and forms the posterior boundary of the lesser sac. Fluid in the lesser sac was frequently seen in children with pancreatic injury and was rare in the absence of pancreatic trauma. Fluid in the anterior pararenal space was seen less frequently in children who had pancreatic injury. Four children with fluid in the lesser sac and anterior pararenal space as an isolated finding had pancreatic injury; the pancreas appeared normal on CT in all four. Unexplained fluid in the lesser sac was never seen after blunt trauma, and unexplained fluid in the anterior pararenal space was present in only one child.

Injury to the main pancreatic duct is a principal determinant in the development of significant complications after pancreatic injury [7, 9, 16]. As a result, major ductal laceration is recognized as an indication for prompt surgical intervention [8, 9, 16]. The presence of peripancreatic fluid collections may be a useful marker for major ductal injury. All six children who had injury to the main pancreatic duct noted at surgery had fluid in the lesser sac on CT examination, and four had fluid in the anterior pararenal space on the initial CT study. Additionally, two of four children in whom a pancreatic pseudocyst developed later had fluid in the lesser sac on the initial CT examination; one of these also had fluid in the anterior pararenal space.

Follow-up examination with CT or sonography was useful in identifying the development of a pancreatic pseudocyst in children with pancreatic injury who had subsequent signs and symptoms. A pseudocyst was noted on later CT or sonographic examination in four (36%) of 11 survivors with pancreatic injury (Fig. 5). The lesser sac was the most common location for these focal fluid collections.

In conclusion, pancreatic injury after blunt trauma may be difficult to identify on CT examination. The presence of fluid in the lesser sac should strongly suggest injury to the pancreas. Conversely, however, the absence of peripancreatic fluid does not exclude pancreatic trauma. Recognition of the limitations of CT diagnosis of pancreatic injury is important in helping to reduce errors of interpretation.

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