World Journal of Gastrointestinal Surgery

Online Submissions: http://www.wjgnet.com/esps/
wjgs@wjgnet.com
doi:10.4240/wjgs.v4.i7.166

World J Gastrointest Surg 2012 July 27; 4(7): 166-170
ISSN 1948-9366 (online)

ORIGINAL ARTICLE

Computed tomography for pancreatic injuries in pediatric blunt abdominal trauma

Hamdi Hameed Almaramhy, Salman Yousuf Guraya

Hamdi Hameed Almaramhy, Salman Yousuf Guraya, Department of Surgery, College of Medicine, Taibah University, Al Madina Al Munawarrah 41477, Saudi Arabia
Author contributions: All authors contributed to this study.
Correspondence to: Hamdi Hameed Almaramhy, Consultant, Assistant Professor, Department of Surgery, College of Medicine, Taibah University, Al Madina Al Munawarrah 41477, Saudi Arabia. drsyg7@yahoo.com
Telephone: +966-3-8581111-31344 Fax: +966-3-8581111-31394
Received: March 11, 2012 Revised: July 16, 2012
Accepted: July 20, 2012
Published online: July 27, 2012

Abstract

AIM: To evaluate the efficacy of computed tomography scan in diagnosing and grading the pattern of pancreatic injuries in children.

METHODS: We conducted a retrospective study to review medical files of children admitted with blunt pancreatic injuries to the Maternity and Children Hospital Al-Madina Al-Munawwarah, Kingdom of Saudi Arabia. The demographic details and mechanisms of injury were recorded. From the database of the Picture Archiving and Communication System of the radiology department, multidetector computed tomography (MDCT) images of the pancreatic injuries, severity, type of injuries and grading of pancreatic injuries were established.

RESULTS: Seven patients were recruited in this study over a period of 5 years; 5 males and 2 females with a mean age of 7 years (age range 5-12 years). Fall from height was the most frequent mechanism of injury, reported in 5 (71%), followed by road traffic accident (1 patient, 14%) and cycle handlebar (1 patient, 14%) injuries. According to the American Association for the Surgery of Trauma grading system, 1 (14%) patient sustained Grade Ⅰ, 1 (14%) Grade Ⅱ, 3 (42%) Grade Ⅲ and 2 (28%) patients were found to have Grade Ⅴ pancreatic injuries. This indicated a higher incidence of severe pancreatic injuries; 5 (71.4%) patients were reported to have Grade Ⅲ and higher on the injury scale. Three (42%) patients had associated abdominal organ injuries.

CONCLUSION: Pediatric pancreatic injuries due to blunt abdominal trauma are rare**.** The majority of the patients sustained extensive pancreatic injuries. MDCT findings are helpful and reliable in diagnosing and grading the pancreatic injuries.

Key words: Pediatric abdominal injuries; Pancreatic hematoma; Pancreatic laceration; Pancreatic transaction

Peer reviewer: Grigory G Karmazanovsky, Professor, Department of Radiology, Vishnevsky Istitute of Surgery, B Serpukhovskaya street 27, Moscow 117997, Russia

Almaramhy HH, Guraya SY. Computed tomography for pancreatic injuries in pediatric blunt abdominal trauma. *World J Gastrointest Surg* 2012; 4(7): 166-170 Available from: URL: http://www.wjgnet.com/1948-9366/full/v4/i7/166.htm DOI: http://dx.doi.org/10.4240/wjgs.v4.i7.166

INTRODUCTION

Isolated pancreatic trauma in children is rare, amounting to less than 2% of all abdominal injuries[1]. Concomitant abdominal visceral injuries with associated pancreatic injuries are reported to be hepatic (46%), gastric (42.3%), major vascular (41.3%), duodenal (19.3%), splenic (28%) and renal (23.4%)[2,3]. The mechanisms of pancreatic injuries in children are diverse; motor vehicle crashes, pedestrian accidents, fall from height, physical abuse and cycle handlebar anteroposterior compression injuries. The ret-

roperitoneal location of the pancreas protects the organ from minor abdominal trauma. The majority of blunt pediatric pancreatic trauma (65%) occurs in the pancreatic body, followed by tail and head of the organ[3].

Rapid diagnosis of pancreatic injuries is essential as there is substantial morbidity and mortality if treatment is delayed. Physical examination is not reliable[4]. Diagnostic peritoneal lavage detects intra-abdominal injuries resulting in hemoperitoneum but is rarely performed in children. However, this modality of investigation does not provide information about the injured organ and the grade of injury[5]. For hemodynamically stable children, abdominal ultrasonography (US) and computed tomography (CT) are liberally used to identify the organ injured and the extent of injury. US has been reported to be 55%-92.5% sensitive with a negative predictive value of 55%-97% and specificity of 83%-100%[6].

CT scanning of the abdomen is currently the most useful tool in evaluating adult and pediatric groups with torso trauma. The majority of stable trauma patients with a high suspicion of intra-abdominal organ injuries require a CT scan. However, the reliability of a CT scan in detecting pediatric pancreatic trauma is still debatable[7,8]. Lee *et al*[7] reported CT scan sensitivity of 78.9% in diagnosing pediatric pancreatic trauma and in defining the extent of pancreatic injury. The purpose of this study is to present the radiological pattern of pediatric pancreatic injuries caused by blunt abdominal trauma, as diagnosed by abdominal CT scan in a tertiary hospital.

MATERIALS AND METHODS

A retrospective audit incorporating the chart review of all consecutive pediatric patients, aged 5-12 years, admitted with established pancreatic injuries due to blunt abdominal trauma was undertaken. The study period encompassed December 2005 to December 2010 at the Maternity and Children Hospital Al Madinah Al Munawarrah, Kingdom of Saudi Arabia. The Maternity and Children Hospital is a major tertiary level referral center for the region, equipped with modern laboratory and radiological gadgets. The pancreatic amylase and lipase and C-reactive protein were used as the serum markers to establish the diagnosis of pancreatic injury. The patients' demographic data and the mechanism of injury were retrieved from the medical files. CT-scan images of the established cases of pancreatic injuries were retrieved from the Picture Archiving and Communication Systems (PACS) system of the radiology department for further analysis and reporting. The pattern, type of organ injury and associated abdominal injuries were recorded and the data were used to classify the pancreatic injuries according to the American Association for the Surgery of Trauma (AAST)[9].

Following admission to the emergency department, all patients were scanned within 2 h of admission by an emergency multidetector CT (MDCT) scanner which reduces motion artefacts and enables high-resolution scans, in particular high quality multiplanar reformatted images. The detector collimation of primary axial image was 0.6-2.5 mm, with a pitch of 1.0-1.8. The axial images were best reconstructed at 2.5-3 mm, with a 10%-20% overlap. Coronal and sagittal reformatted images were used routinely at 1.8-2.5 mm thickness. A volume of 100-120 mL (2 mL/kg of body weight) of contrast medium (iodine, 300-370 mg/mL) was injected at 3-6 mL/s with a delay of 60-70 s in the portal venous phase. Arterial scans (25-30 s delay) in a whole-body CT-scan protocol was applied which provide images during the pancreatic parenchymal phase. Delayed scanning (at 2-3 min) was performed to rule out any abdominal or pancreatic hemorrhage. The described CT scan technique included the use of positive oral contrast media. All the images were stored in the radiology PACS database and were available for reviewing and interpretation. The CT scans were repeated as and when required for the admitted patients.

RESULTS

A total of 7 patients made this study group; 5 male and 2 females with a mean age of 7 years (age range 5-12 years). Fall from height was the commonest mechanism of injury, recorded in 5 (71%), followed by traffic accident (1 patient, 14%) and cycle handlebar (1 patient, 14%) injuries. According to the AAST scoring grading system, 1 (14%) patient sustained Grade Ⅰ (Figure 1), 1 (14%) Grade Ⅱ (Figure 2), 3 (42%) Grade Ⅲ (Figure 3) and 2 (28%) patients were found to have Grade Ⅴ (Figure 4) pancreatic injuries. Three (42%) patients had associated abdominal organ injuries. Associated injuries were splenic lacerations in two patients and uretropelvic disruption of left kidney in one patient. Peripancreatic fluid collection in MDCT was noted in 2 patients; fluid was in maximum amount in the lesser sac.

DISCUSSION

Prompt diagnosis of pancreatic injuries in children is essential for timely management. Detection of the injury pattern using a CT scan depends on a reliable and robust technique, especially the timing of an emergency CT study and correct timing of the contrast bolus[10]. In the reported literature, initial CT scan findings of patients with pancreatic injuries may be within normal limits in the first 12 h after injury. CT scan diagnoses of the pancreatic injuries revealed variable sensitivity and specificity because many findings are subtle, absent or, at times, slow to develop. The sensitivity and specificity of a CT scan in detecting pancreatic trauma of all grades has been reported to be around 80% and the grades of injury tend to be underestimated with a CT scan[11-13].

Pancreatic duct injury is reported to occur in approximately 0.12%-0.4% of pediatric trauma cases[14,15]. The consequences of ductal disruption are serious, with significant morbidity and mortality, especially when diagnosis is delayed for more than 6 h. Wong *et al*[16] suggested that a CT scan finding of a lesion of more than 50% of

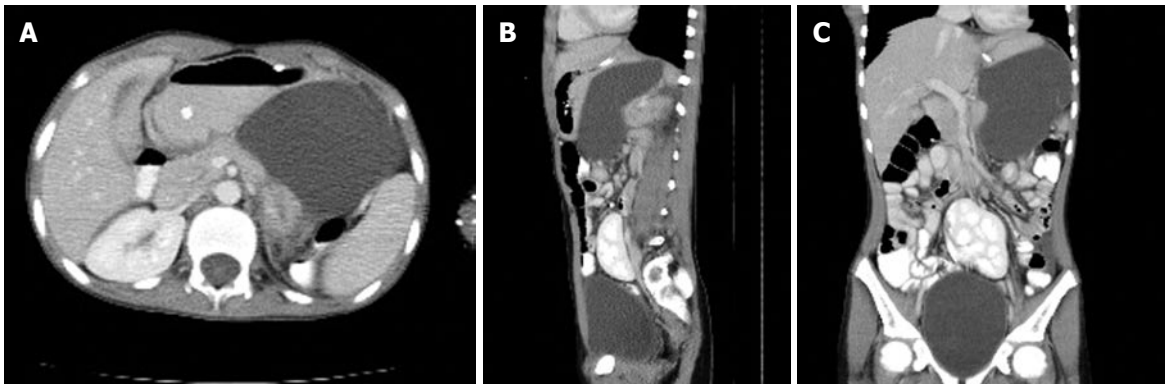

Figure 1 Abdominal computed tomography scan axial (A), sagittal (B) and coronal (C) images of the patient with Grade Ⅰ pancreatic injury, showing hematoma in the lesser sac and inferomedial displacement of left kidney.

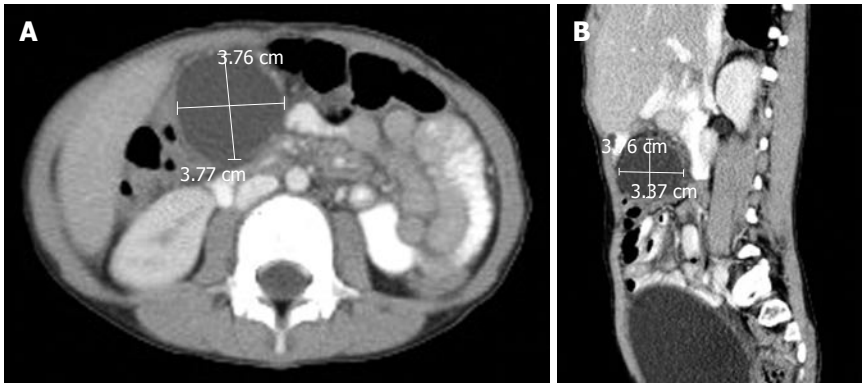

Figure 2 Abdominal computed tomography scan axial (A) and sagittal (B) views showing Grade Ⅱ pancreatic injury with hematoma measuring 3.7 cm × 3.7 cm. No other associated injuries were found.

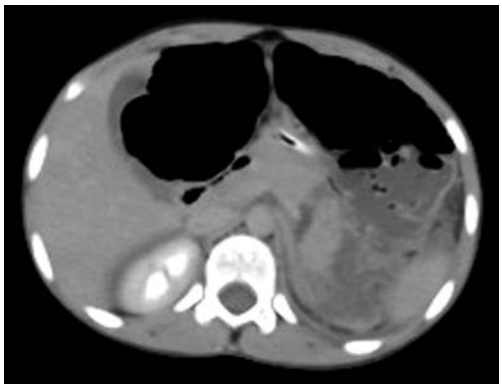

Figure 3 Abdominal computed tomography scan axial view (delayed phase) demonstrating Grade Ⅲ pancreatic injury with distal transaction of pancreatic tail, dilated loop of transverse colon, and hemoperitoneum. There is peripancreatic fat stranding as well.

Figure 4 Abdominal computed tomography scan axial view showing Grade Ⅴ pancreatic injury with shattered head of pancreas.

the thickness of pancreas indicated likely disruption of the pancreatic disruption. In our study, 3 patients were reported to have pancreatic ductal injuries, indicating the severity and extensive nature of pancreatic injuries. AAST has devised a Pancreas Organ Injury Scale (Table 1) to standardize the diagnosis and treatment of pancreatic injuries. Accordingly, the management strategies have been outlined, predominantly dictated by the AAST Grading Scale. Initial serum amylase levels are not sensitive or specific for predicting pancreatic injury. Jones reported that up to 35% of patients with complete transaction of the main pancreatic duct may exhibit normal serum amylase levels[17]. Serial or delayed serum amylase levels have been more useful[18]. The degree of elevation of serum levels of amylase is not indicative of the severity of injury. CT scan is the preferred imaging modality for the diagnosis of intra-abdominal solid organ injury, including the pancreas[19]. The introduction of MDCT allows for high-resolution scans and multiplanar reformations that improve diagnostic and interventional capabilities. Specific

Table 1 American Association for the Surgery of Trauma Organ Injury Score for pancreatic injury

Grade	Injury	Description
I	Hematoma	Mild contusion without duct injury
	Laceration	Superficial laceration without duct injury
II	Hematoma	Major contusion without duct injury
	Laceration	Major laceration without duct injury
III	Laceration	Distal transaction or parenchymal injury with duct injury
IV	Laceration	Proximal transaction or parenchymal injury involving ampulla
V	Laceration	Massive disruption of pancreatic head

diagnostic features include pancreatic fractures with or without separation of the fragments, pancreatic enlargement or hematoma, fluid separating the splenic vein and pancreas, and increased attenuation of fat around the pancreas. The use of MDCT has dramatically reduced the scan acquisition time, resulting in improved patient compliance and image quality[20]. Multiplanar reconstruction and curved views of MDCT were reported to be helpful in the accurate diagnosis of pediatric pancreatic transactions[21].

On MDCT, pancreatic fractures or lacerations appear as hypoattenuating linear findings in the pancreatic parenchymal phase, ideally with separated structures, which can be missed on native CT images. On the other hand, pancreatic contusions appear as a diffuse or localized hypoattenuating area in the pancreatic parenchymal phase within the normally enhancing parenchyma. Complete disruption of the pancreas can result in extended hypoperfusion of the organ[1]. Figure 2 in the present study shows a pancreatic hematoma appearing as hypoattenuating lesions within the margins of the pancreas. A recent study reported that localized blood collection can be found between the pancreatic parenchyma and the splenic vein in up to 90% of pancreatic injuries[22]. The diagnostic accuracy of MDCT in the detection of pancreatic ductal transaction is lower compared to endoscopic retrograde cholangiopancreaticography (ERCP). ERCP is the most reliable diagnostic tool to accurately define the continuity of the main pancreatic duct following pancreatic trauma; it constitutes an integral part of the management of pediatric patients with pancreatic injuries[23]. It has been strongly suggested as an effective procedure for diagnosis and therapeutic interventions, including stent placement[24]. The invasive nature and the associated complications are the major drawbacks of ERCP, limiting its use in unstable and uncooperative patients.

CT scan findings of pancreatitis, such as focal or diffuse organ enlargement, contour irregularity and loss of definition of adjacent fat planes, were not recorded on images taken immediately after the injury[25]. Posttraumatic pancreatitis results from direct blunt force and autodigestion by liberation of pancreatic enzymes after the injury[26]. Consequently, detectable pancreatic inflammatory changes evolve later[27]. This limitation of CT scans should be kept in mind while dealing with suspected pancreatic injuries in children. Serial CT scans in admitted patients is strongly recommended for accurate and reliable information. The presence of peripancreatic fluid in the absence of obvious abdominal viscus injury strongly suggests pancreatic injury[25]. The pancreas is situated in the anterior pararenal space and forms the posterior boundary of the lesser sac. Fluid in the lesser sac is frequently reported in children with pancreatic injury.

CT scan, in association with serial serum amylase measurements, is considered to be the most accurate, non-invasive strategy for follow-up of trauma victims[28]. Because of radiation exposure in CT scans, contrast-enhanced ultrasound has recently been reported in the detection of traumatic pancreatic injuries[29]. The complete examination is safe and rapid (4-6 min) and easily available at the bedside. The safety of the contrast medium SonoVue has been confirmed by many published reports[30,31]. However, the need for a trained sinologist cannot be overemphasized and the results are operator-dependent, with associated variability of judgment.

To conclude, pediatric pancreatic injuries sustained by blunt abdominal trauma are extremely rare**.** Once pancreatic injuries occur, they are often quite extensive and associated with other abdominal organ injuries. MDCT images, if performed appropriately and timely, are helpful and reliable in diagnosing and defining the severity of pancreatic injuries.

COMMENTS

Background

Isolated pancreatic trauma in children is rare, amounting to less than 2% of all abdominal injuries. Concomitant abdominal visceral injuries with associated pancreatic injuries are reported to be hepatic, gastric, major vascular, duodenal, splenic and renal. The mechanisms of pancreatic injuries in children are diverse; motor vehicle crashes, pedestrian accidents, fall from height, physical abuse and cycle handlebar anteroposterior compression injuries.

Research frontiers

A retrospective audit incorporating the chart review of all consecutive pediatric patients, aged 5-12 years, admitted with established pancreatic injuries due to blunt abdominal trauma was undertaken. The study period encompassed December 2005 to December 2010 at the Maternity and Children Hospital Al Madinah Al Munawarrah, Kingdom of Saudi Arabia.

Innovations and breakthroughs

The purpose of this study is to present the radiological pattern of pediatric pancreatic injuries caused by blunt abdominal trauma, as diagnosed by abdominal computed tomography scan in a tertiary hospital.

Applications

The author concluded that pediatric pancreatic injuries due to blunt abdominal trauma are rare**.** The majority of the patients sustained extensive pancreatic injuries. multidetector computed tomography findings are helpful and reliable in diagnosing and grading the pancreatic injuries.

Peer review

The authors evaluated the efficacy of computed tomography scan in diagnosing and grading the pattern of pancreatic injuries in children. This study is interesting.

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S- Editor Wang JL **L- Editor** Roemmele A **E- Editor** Zheng XM