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ORIGINAL ARTICLE

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The use of MRCP in the detection of pancreatic injuries after blunt trauma

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Abstract From January 2000 to November 2001, five consecutive, hemodynamically stable trauma patients (age range 8–69 years, mean age 34 years) with parenchymal injuries were evaluated by magnetic resonance imaging (MRI) with magnetic resonance cholangiopancreatography (MRCP). One patient also underwent a MRCP-facilitated secretin test. MRI depicted pancreatic laceration in two patients, ductal disruption and a post-traumatic intraparenchymal pseudocyst in one, migrating pancreatic fluid collection in the mediastinal space with disruption in another, and main pancreatic duct rupture and dilatation in the patient evaluated with MRCP following secretin administration. MRI with MRCP is an effective noninvasive test for detecting and managing pancreatic injuries after blunt trauma. Secretin administration improves ductal visualization, particularly of nondilated ducts. Finally, MRI was useful in the follow-up studies of parenchymal damage and minor ductal injuries, providing high-quality images of the pancreatic duct and biliary tract.

Keywords Pancreatic duct, injury · Pancreatic ducts, MRCP · Abdominal trauma, MRI

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Introduction

The diagnosis of pancreatic injuries after abdominal trauma is often difficult and is rarely made preoperatively [1, 2]. Evaluation of pancreatic integrity is important in order for an appropriate management approach to be decided. Typically, minor parenchymal injuries are treated nonoperatively whereas main pancreatic duct injuries and parenchymal lacerations usually require surgery or therapeutic endoscopy [3, 4]. Endoscopic retrograde pancreatography (ERP) is the well-established standard of reference for imaging the pancreatic ducts in stable patients [5, 6, 7, 8]. Recently, magnetic resonance imaging (MRI) with magnetic resonance cholangiopancreatography (MRCP) has come to be considered a promising noninvasive alternative imaging technique in the evaluation of pancreatic injuries, by virtue of its excellent spatial resolution and direct visualization of the entire pancreaticobiliary tract [9, 10, 11, 12, 13, 14]. The object of this study is to report the capabilities and limitations of MRI in the evaluation of pancreatic injury evaluation after blunt trauma based on a retrospective analysis.

Materials and methods

From January 2000 through November 2001, five consecutive male, hemodynamically stable trauma patients (age range 8–69 years, mean age 34 years) presenting with pancreatic injuries were evaluated at our institution with MRI and MRCP, within 24–48 h after blunt abdominal trauma, primarily to evaluate the status of the pancreatic duct. On admission four patients underwent plain film, US, and contrast-enhanced helical CT which detected the pancreatic injury. One patient underwent MRI 20 days after the trauma and was also evaluated with an MRCP-facilitated secretin test.

MRI was performed on a 1.5-T system (EDGE, Eclipse Marconi, Ohio), using a body coil or body flex phased array coil. The MRI protocol included fat-suppressed breath-hold T1-weighted RF fast axial sequence (TR/TE, 137/4.5; acquisition, 1; matrix, 128×256; scan time, 14 s) and T2-weighted fast spin echo axial sequence (TR/TE 320/10; acquisition, 1; matrix, 192×256; echo

train length, 4; scan time, 12 s); T2-weighted fast spin-echo axial sequence (TR/TE, 10000/110 ms; acquisition, 3; matrix, 256×256; echo train length, 64; scan time, 4 min 40 s).

MRCP was performed with a breath-hold, two-dimensional single shot RARE (rapid acquisition with relaxation enhancement) heavily T2-weighted sequence, along the coronal plane. Parameters employed were: TR/TE, 10000/110 ms; slice thickness, 5 mm; matrix, 256×256; acquisition, 1; echo train length, 140; scan time, 10 s); maximum intensity projection (MIP) and multiplanar reformation (MPR) post-processing was performed. In all patients, we also performed a breath-hold single-slab half-Fourier rapid acquisition with relaxation enhancement sequence (TR/TE, infinite/285; slab, 6; section thickness, 50–70 mm; acquisitions, 1; matrix, 256×256; echo train length, 264; scan time, 8 s).

An MRCP-facilitated secretin test was performed with a dynamic, breath-hold, two-dimensional single shot RARE heavily T2-weighted sequence, along the coronal plane. Parameters employed were: TR/TE, ∞/800–1100 ms; slice thickness, 25–35 mm; matrix, 256×256; 0.5 NEX; FOV 26–35 cm. No post-processing was performed.

To eliminate overlapping fluid-containing organs, a negative contrast agent consisting of 150–200 ml superparamagnetic iron oxide particles (ferumoxsil, Lumirem, Aulnay-sous-Bois, France) was administered orally before dynamic imaging.

A set of MRCP images was acquired before secretin administration to optimally depict the entire main pancreatic duct. After intravenous administration of secretin (Sekretolin; Hoechst, Frankfurt-am-Main, Germany) at a dosage of one clinical unit per kilogram of body weight, the optimal MRCP slice was repeated every 30 s. The dynamic procedure was conducted over 10 min.

Results

In two patients, MRI confirmed the CT findings of deep pancreatic laceration at the "isthmus/body" level, as well as parenchymal and peripancreatic fluid collection. Moreover, MRI examination also depicted integrity of the main duct (Fig. 1).

In the third patient, (Fig. 2), MRCP revealed complete ductal disruption with evidence of a post-traumatic intraparenchymal pseudocyst. In this case, ERCP confirmed MR findings, showing a direct communication between the main duct and the intraparenchymal fluid collection.

In the fourth patient, (Fig. 3), MRI showed a migrating pancreatic fluid collection in the posterior mediastinal space, previously reported on the contrast-enhanced helical CT scans, showing disruption of a secondary pancreatic ductal branch.

In the fifth patient, who was evaluated for two episodes of acute recurrent pancreatitis 20 days after the trauma, MRI demonstrated dilatation of the main pancreatic duct at the body-tail level (Fig. 4a). On the suspicion of ductal injury, a dynamic MRCP was performed after secretin administration that detected the main pancreatic duct rupture with dilatation (Fig. 4b,c).

The patient with main ductal disruption was referred for surgery, while the others underwent conservative management and were assessed by follow-up MR studies.

In the two patients with pancreatic lacerations, an MR follow-up study showed a progressive diminution of the fluid collections, with residual delayed pseudocysts at the site of the injury (Fig. 5).

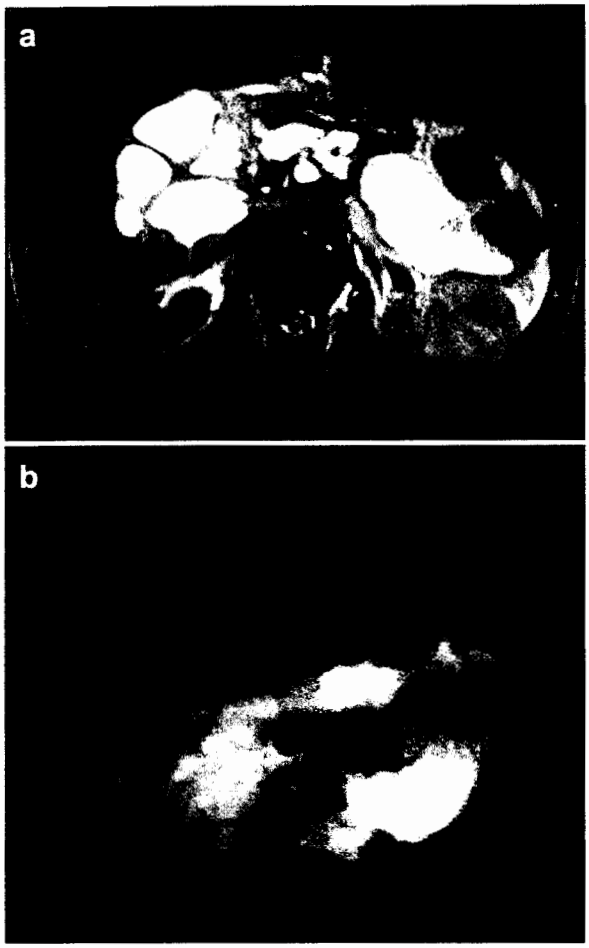

Fig. 1a, b A 32-year-old man with pancreatic laceration following motor vehicle collision. Axial fast spin echo T2-weighted MR image (**a**) shows peripancreatic and intrapancreatic fluid collections occupying the space between the gland fragments. MR cholangiopancreatogram (**b**) shows peripancreatic fluid collection and ductal system integrity. Note the origin of the V biliary branch from the common bile duct

In the patient with mediastinal pseudocyst, a spontaneous resolution of the fluid collection was observed on an MR follow-up examination 2 months later.

Discussion

Pancreatic injuries may be related to blunt, penetrating, or iatrogenic trauma [1, 2]. Blunt pancreatic injury is most frequently encountered following automobile or motorcycle accidents, and usually derives from compression of the gland against the spine [3, 4]. Treatment is conservative in cases of pancreatic contusion and subcapsular fracture, while surgery is generally required when there is rupture of the main pancreatic duct and duodenal pancreatic injuries [1, 3].

The prognosis depends on the extent of damage and is greatly influenced by the presence of associated organ

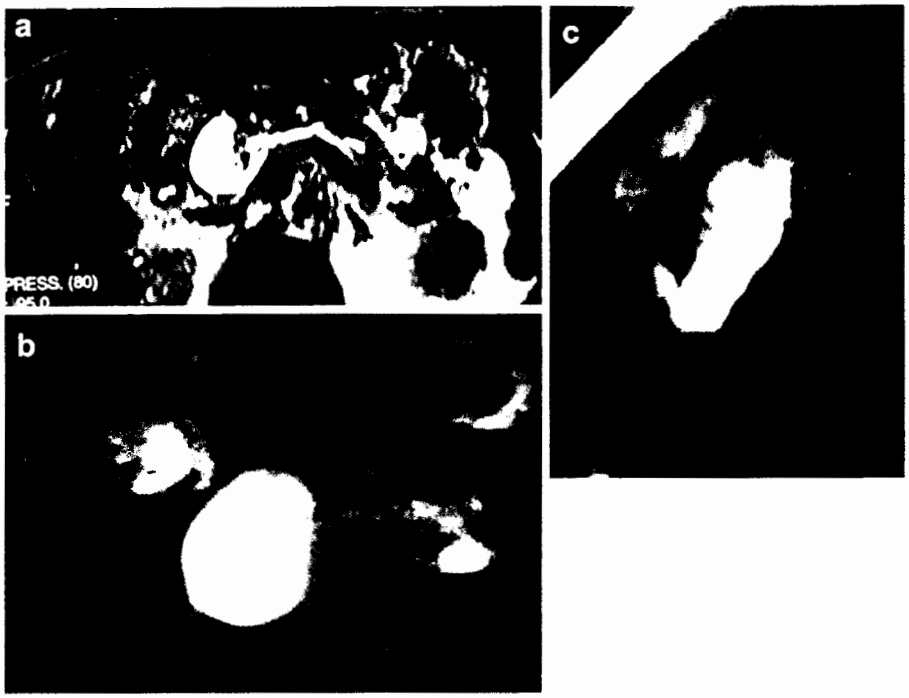

Fig. 2a–c The pancreatic duct entering a post-traumatic pseudocyst in 54-year-old man who presented elevated serum amylase and lipase values. Axial FSE T2-weighted MRI (**a**) and MRCP (**b**) showing larger caliber of the pancreatic duct at the body–tail level, contiguous with a 3.5-cm pseudocyst, compressing the main biliary duct. ERCP (**c**) shows rupture of the main pancreatic duct with a communicating intraparenchymal pseudocyst

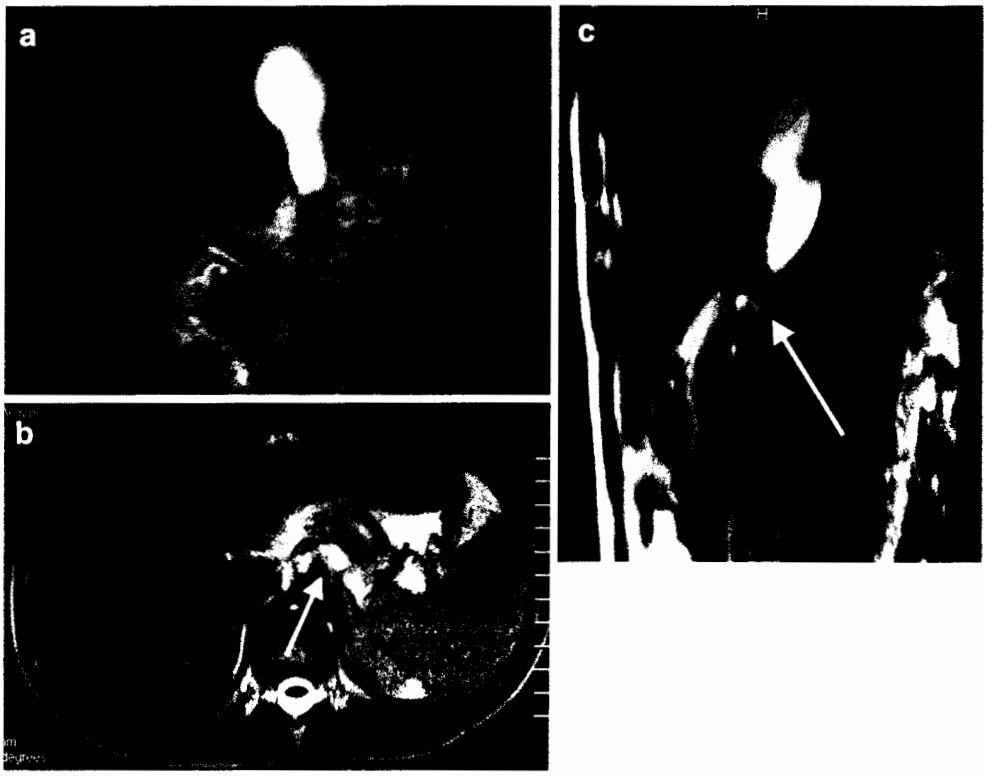

Fig. 3a–c A 9-year-old boy after a fall from a bicycle 24 h previously. Coronal FSE T2-weighted MRI (**a**) shows a large pseudocyst in the posterior mediastinal space. Axial T2-weighted MRI (**b**) demonstrates a small fluid collection in the peripancreatic fat (*arrow*). Disruption of a ductal side branch at the pancreatic tail level was suspected. Sagittal view (**c**) at the pancreatic body demonstrates the continuity of the mediastinal pseudocyst with the pancreatic gland (*arrow*)

injuries [3]. Mean mortality rate is 19%, with a range of 5–37% [2].

The diagnosis of pancreatic injury in patients suffering from abdominal trauma is difficult and rarely made preoperatively; it has been postulated that many conservatively managed patients may have mild, undetected pancreatic injuries [15]. Clinical findings are often nonspecific and/or of poor diagnostic value [1].

Contrast-enhanced helical CT is considered the imaging method of choice for examining patients with suspected pancreatic trauma [16, 17]. However, CT cannot directly detect pancreatic duct disruption unless

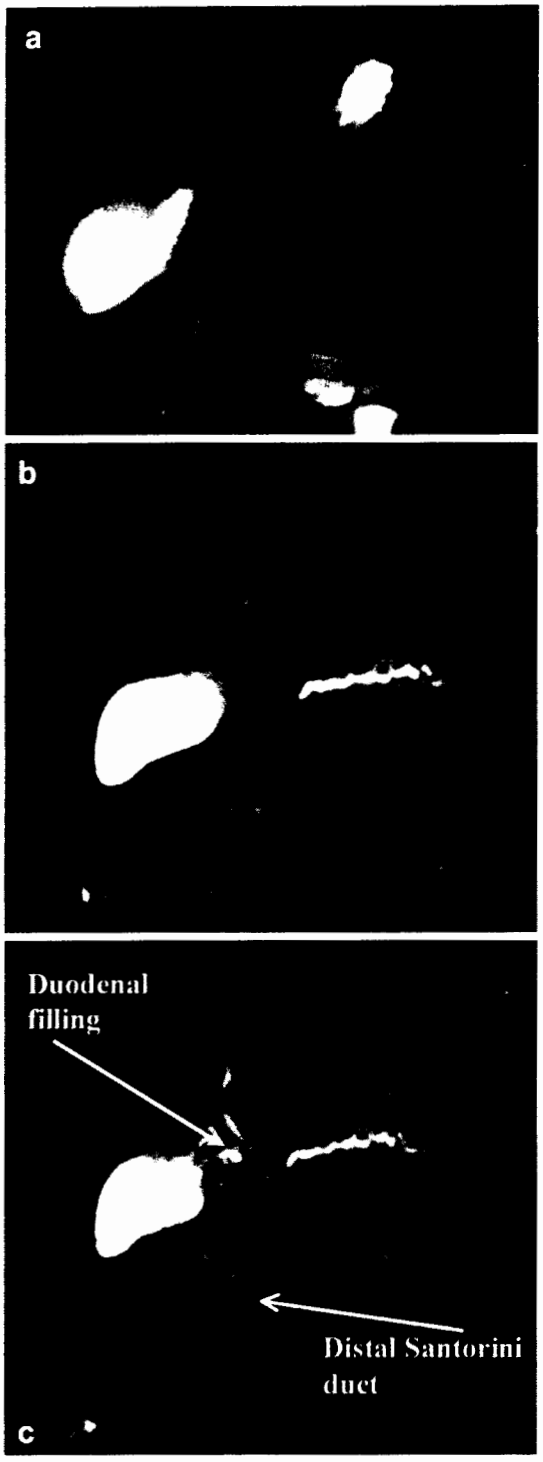

Fig. 4a–c High-grade, post-traumatic stricture of the main pancreatic duct in a 12-year-old boy who sustained blunt abdominal trauma during a motor vehicle crash 20 days before, complaining of abdominal pain and recurrent pancreatitis. MRCP (**a**) illustrates an abrupt transition between normal and dilated duct at the same level. Coronal single shot RARE MRCP (**b**) before the administration of secretin shows rupture of the main pancreatic duct in the body of the pancreas. The upstream duct in the tail is dilated as well as the side branches. Coronal single shot RARE MRCP (**c**) after secretin administration better depicts the downstream duct in the head of the gland, and the presence of the disruption. The main pancreatic duct reaches minor papilla, indicating a dominant dorsal duct configuration

dislocation of transected ductal margins is identified [18, 19]. Since the integrity of the pancreatic duct system is crucial for the appropriate management approach [20, 21], early identification of ductal disruption has been advocated.

Recently, ERCP has been indicated for imaging of the pancreatic duct, playing a pivotal role in the management of stable trauma patients [5]. However, ERCP has the limitations of invasiveness of technique (3–5%) and difficulty of performing the procedure in acute trauma patients [6, 7]. Hence, a potential use for MRI in the setting of abdominal trauma has been recently suggested [9, 10, 11, 12, 13, 14].

Nirula et al. [14] described their experience using MRCP in four trauma patients and concluded that it is an attractive technique for the evaluation of pancreatic injuries. However, their patients did not undergo ERCP to confirm the MRCP findings.

Soto et al. [10] described their experience with MR pancreatography for the identification of main pancreatic duct integrity in seven trauma patients. MR pancreatography accurately depicted the status of the duct and the site of duct disruption in all patients.

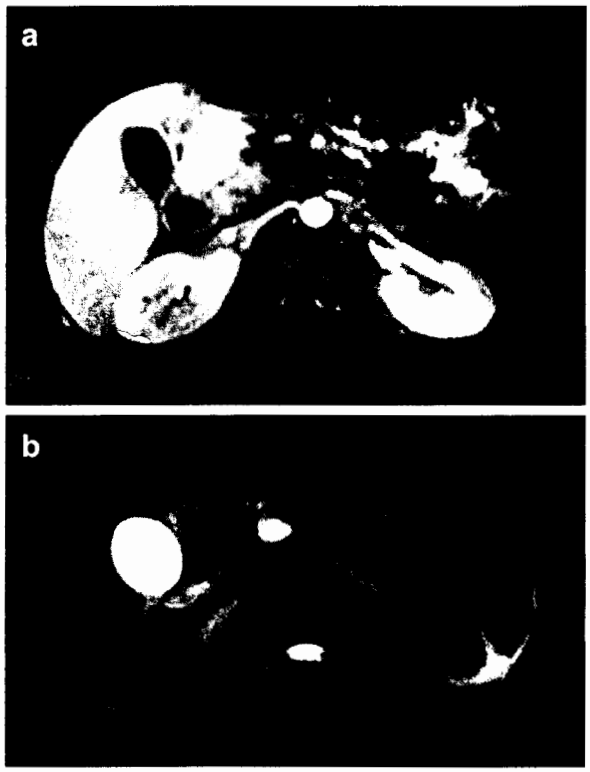

Fig. 5a, b A 25-year-old man with upper abdominal trauma following a motorcycle crash. Fat-suppressed T1-weighted axial MR image (**a**) shows the site of pancreatic laceration and a fluid collection. An MRCP (not shown) revealed ductal integrity. The follow-up study after 20 days (**b**) shows a residual pseudocyst at the level of injury

Moreover, segments of the duct located beyond the injury site were well displayed on MR pancreatography but not on ERCP.

In our experience, MRI revealed ductal integrity in two patients in whom CT findings were only suggestive, and varying degrees of ductal damage in the other three patients. Moreover, MRI findings directed the decision to proceed with therapeutic ERCP in the patients with complete ductal disruption and ductal stricture (stent placement).

Secretin administration improves ductal visualization, particularly of nondilated ducts. It is therefore helpful to visualize the normal-sized downstream duct and the distance between the two extremities, to plan appropriate therapy.

Finally, MRI was particularly useful in the follow-up of parenchymal damage and minor ductal injuries, providing high-quality images of the pancreatic duct and biliary tract, without the requirement of the contrast material administration or radiation. To our knowledge, the capabilities of MRI in follow-up studies have not been reported before.

The limitations of our study are the small number of patients and the absence of surgical confirmation of the MR findings. Thus, a larger series is advocated to define the role of MR in the diagnostic algorithm.

Although our conclusions are restricted by the small number of patients, our data suggest that MRCP is an effective noninvasive alternative for determining pancreatic ductal integrity in trauma patients. Given the risks of significant procedure-induced pancreatitis and other complications that can occur with ERCP, the noninvasive nature of MRCP makes it an appealing diagnostic test, useful for diagnosis and for planning therapeutic surgical or retrograde interventions in such patients.

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