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Management of endoscopic retrograde cholangiopancreatography: related duodenal perforations

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Abstract
Background As the performance of upper gastrointestinal endoscopy, especially endoscopic retrograde cholangiopancreatography (ERCP), has increased since 1968, so has the incidence of duodenal perforations. The frequency of ERCP use varies among hospitals and depends on the availability of trained endocopists, equipment, and facilities.
Methods A retrospective review of ERCP-related perforations to the duodenum was conducted to identify their incidence, optimal management, and clinical outcome. Charts were reviewed for the following data: ERCP indication, clinical presentation, diagnostic methods, time to diagnosis and treatment, type of injury, management, length of hospital stay, and clinical outcome.
Results From April 1999 to February 2008, 4,358 ERCP were performed, 15 of which (0.34%) resulted in perforation to the duodenum. Only four of the perforations were discovered during ERCP, with another eight requiring computed tomography or abdominal radiography for diagnosis. Surgery was performed for 13 of the patients (87%), and 2 patients died (15%). One patient was managed conservatively with a successful outcome. Nine patients underwent surgery within 24 h after the ERCP, with only one patient undergoing surgery after 24 h. The overall mortality rate was 20% (3 of 15 patients).
Conclusions Clinical and radiographic features can be used to determine the surgical or conservative treatment of ERCP-related duodenal perforations, whereas patient age and intraoperative findings can determine the final outcome and morbidity or mortality. The interval between the perforation and the operation is of great significance. The mortality rate increases dramatically with late surgical management (>24 h). An algorithm for the selective management of ERCP-induced duodenal perforations is proposed.

Keywords Conservative management · Endoscopic retrograde cholangiopancreatography · Perforation · Surgical management

Since its introduction in 1968, endoscopic retrograde cholangio-pancreatography (ERCP) has become a very common procedure for the evaluation and treatment of biliary and pancreatic diseases. Sphincterotomy is used mainly to remove biliary stones, drain the biliary tree, and facilitate the placement of stents in the common bile and pancreatic duct [1]. As the performance of upper gastrointestinal endoscopy, especially ERCP has increased everywhere, so has the incidence of iatrogenic intestinal perforation. Duodenal injury is reported to have an incidence of 0.3% to 1.3% [2–4], with a relatively high mortality rate of 16% to 18% [5].

Retroperitoneal duodenal perforations represent the majority of cases and usually are due to papillotomy, whereas intraperitoneal perforations are much less common and caused by the endoscope itself [4]. Because these injuries are rare, no consensus exists on management guidelines. Recommendations have been based on anecdotes and small case series.

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Traditionally, duodenal perforations after ERCP have been managed surgically. However, over the past decade, cases of successful conservative management for carefully selected patients have been reported [6]. In this study, we present the largest published series from a single U.S. medical center of ERCP-related duodenal perforations based on clinical and radiologic criteria for presentation, location of the perforation, type of treatment, and final clinical outcome.

Patients and methods

After approval by the institutional review board of our hospital, a retrospective review of ERCP-related duodenal perforations was conducted during a 9-year period in an attempt to identify their incidence, optimal management, and clinical outcome. Medical records were reviewed for the following data: patient demographics, ERCP indication, clinical presentation after the suspected perforation, diagnostic laboratory and radiologic studies, time between ERCP and diagnosis and treatment, type of management, intraoperative findings, final pathology, length of hospital stay, clinical course, and final outcome.

The duodenal perforations were categorized according to the working classification proposed by Stapfer et al. [5] (Table 1). The characteristics of the study population are presented in Table 2. Primarily, clinical and radiologic criteria were used to determine operative or conservative management. Stable patients without clinical signs of peritonitis were observed, whereas patients with hypotension (systolic blood pressure, <90 mmHg), tachycardia (heart rate, >120/min), or fever (temperature, >101.5°F) were observed. Categorical variables were compared by means of the chi-square test, whereas continuous variables were analyzed using Student's *t*-test.

Results

From April 1999 to February 2008, 4,358 ERCPs were performed, 15 (0.34%) of which resulted in small bowel perforation. These 15 patients included 6 men (40%) and 9 women (60%) with a median age of 69 years (range, 34–87 years). The ERCP was elective for removal of common bile duct stones in nine cases (60%), for treatment of bile leak after laparoscopic cholecystectomy in one case, for workup preceding elevated liver function tests in three cases, for cholangiocarcinoma in one case, and for periampullary tumor in one case.

Table 1 Types of duodenal perforations and their respective management introduced by Stapfer et al. [5]

Type	Definition	Rx
1	Lateral duodenal wall	Surgery
2	Peri-Vaterian	Surgery if large free air
3	Ductal	Same as 2
4	Retroperitineal air alone	Conservative

Only four of the perforations (27%) were discovered during the ERCP procedure, whereas the remaining 11 (73%) required computed tomography, abdominal radiograph, or both for diagnosis (Figs. 1 and 2). Surgery was performed for 13 of the patients (87%), and two deaths (15%) occurred. One patient was managed conservatively with a successful outcome. One patient refused surgery initially and was managed conservatively, but consented to surgery a few weeks afterward, then finally died postoperatively of septic shock. Nine patients underwent surgery within 24 h after the ERCP, and five after 24 h. Nine of the perforations (60%) were type 1 (lateral duodenal), three (20%) were type 2 (peri-Vaterian), one was type 4 (retroperitoneal air alone), and two were of unknown classification.

The median hospital stay was 21 days (range, 8–75 days) or longer for the patients who underwent surgery ($p = 0.46$) and for the patients who had surgery 24 h after the ERCP ($p < 0.05$). For the patients who underwent operative management, the time between the diagnosis and the operation was of significant importance for survival. The interval was much shorter for the patients who survived than for those who died (mean, 17.4 vs 440 h; $p < 0.05$). The overall mortality rate was 20% (3 of 15 patients), with death resulting from sepsis in two cases and from uncontrolled bleeding of the gastroduodenal artery in one case.

With regard to the clinical presentation of patients, the signs and symptoms were always abdominal pain with or without abdominal distention, leukocytosis, and fever. Conservative management consisted of bowel rest, nasogastric tube decompression of the upper gastrointestinal tract, and broad-spectrum intravenous antibiotics such as piperacillin/tazobactam or vancomycin, ciprofloxacin, and metronidazole. Of the 14 patients who underwent surgery, 11 (79%) had primary repair of the duodenal perforation with an omental patch, together with pyloric exclusion and gastrojejunostomy. In one patient, the exact location of the perforation was not clearly identified at surgery due to extensive scarring and adhesion formation, whereas one patient received only primary repair of the duodenal perforation with an omental patch and choledochoduodenostomy due to stricture of the common bile duct.

Table 2 Patient characteristics

Age/gender	ERCP indication	Symptoms & signs	Dx	Type of perforation[a]	Time between ERCP and OR	Type of Rx	Type of operation	LOS/outcome[b]
40/F	Bile leak[c]	Pain, distention	CT, UGI	1 (3rd, 20 mm)	3 h	Surgical	Repair, PE, GJ	31 days/well
34/F	CBD stones	Pain	During ERCP	1 (2nd, 15 mm)	2 h	Surgical	Repair, PE, GJ	17 days/well
81/F	CBD stones	Pain	During ERCP	1 (3rd, 30 mm)	3 days	Surgical	Repair, PE, GJ	11 days/well
73/M	CBD stones	Pain	CT	1 (3rd, 40 mm)	4 h	Surgical	Repair, PE, GJ	9 days/well
87/F	CBD stones	Pain	CT	2 (2nd, 13 mm)	12 h	Surgical	Repair, PE, GJ	25 days/well
79/M	CBD stones	Pain, distention	CT	4 (3rd, 1 cm)	2 h	Conservative: NPO, NGT, 4 Abx	–	8 days/well
83/F	CBD stones	Pain	During ERCP	1 (3rd, 10 mm)	2 h	Surgical	Repair, PE, GJ	14 days/well
66/M	Cholangiocarcinoma	Pain	KUB	1 (2nd, 15 mm)	3 h	Surgical	Repair, PE, GJ	12 days/well
71/F	Abnormal LFTs	Pain, fever, leukocytosis	CT	I (3rd, 12 mm)	3 days	Surgical	Repair, CBD	21 days/well
61/M	CBD stones	pain, fever, leukocytosis	CT	Unknown	6 days	Surgical	Unable to find the perforation	17 days/died (sepsis)
55/M	CBD stones	Pain, fever, leukocytosis	CT	Unknown	7 days	Surgical	Repair, PE, GJ	14 days/died (bleeding)
76/F	Abnormal LFT	Pain, fever, leukocytosis	CT	2 (2nd, 14 mm)	42 days	Conservative intially: NPO, NGT, 4 Abx, surgical finally	Repair, PE, GJ, CC, CBD exploration	75 days/died (sepsis, MI)
71/F	CBD stones	Pain	CT	1 (2nd, 9 mm)	2 h	Surgical	Repair, PE, GJ	11 days/well
84/M	Jaundice	Pain	CT	1 (2nd, 20 mm)	2 h	Surgical	Repair, PE, GJ	19 days/well
87/F	CBD stones	Pain	CT	2 (2nd, 10 mm)	3 h	Surgical	Repair, PE, GJ	27 days/well

ERCP, endoscopic retrograde cholangiopancreatography; Dx, diagnosis; OR, operation; Rx, prescription; LOS, length of hospital stay; CT, computed tomography; UGI, upper gastrointestinal; PE, physical examination; GJ, gastrojejunostomy; CBD, common bile duct; MI, myocardial infarction; NPO, nothing by mouth; NGT, nasogastric tube; Abx, antibiotics; LFT, liver function test; CC, cholecystectomy

[a] According to Stapfer et al. [5]

[b] LOS = length of stay (days)

[c] Bile leak from cystic dump stump following laparoscopic cholecystectomy

Fig. 1 Computed tomography of a perforation in the second portion of the duodenum showing the formation of intraperitoneal abscess

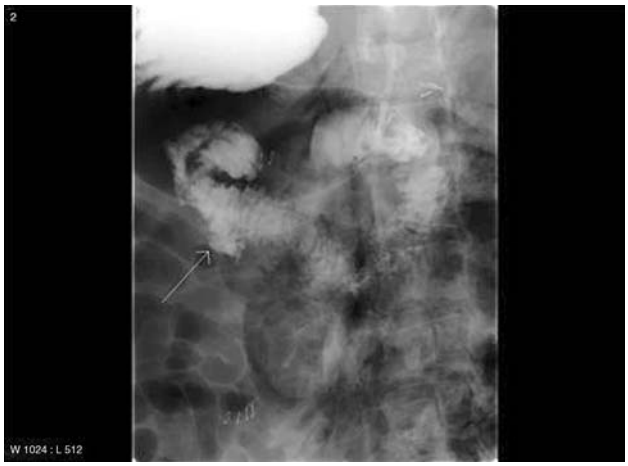

Fig. 2 Upper gastrointestinal series showing a perforation in the second portion of the duodenum with extravasation of contrast material (*arrow*)

Discussion

Generally, ERCP is regarded as a safe procedure in the hands of experienced gastroenterologists. However, the rate of major complications approaches 10%, with bleeding, pancreatitis, cholangitis, and perforation among the most morbid complications. The overall mortality rate of the procedure is approximately 1% to 1.5% [7, 8]. Perforation of the duodenum is a major complication, with great mortality if left untreated.

Although duodenal injuries have historically been managed surgically, over the past decade, some authors have proposed selective conservative management on a case-to-case basis [4, 7, 9]. The lack of clear and specific

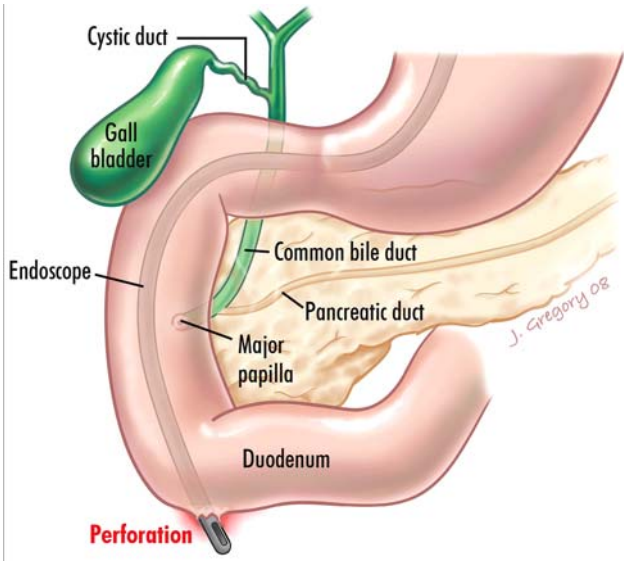

Fig. 3 Schematic representation of perforation with the side-view scope between the second and third portions of the duodenum

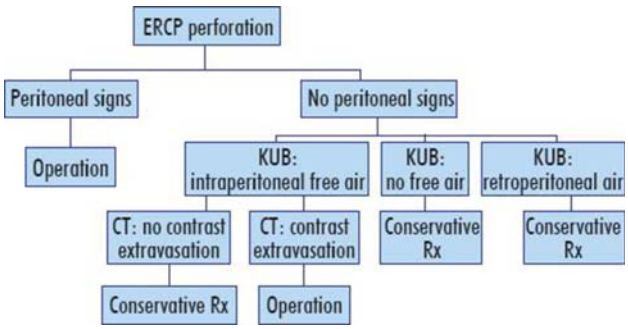

Fig. 4 Algorithm for the management of endoscopic retrograde cholangiopancreatography (ERCP)-related duodenal perforations based on clinical and radiologic findings

guidelines is mainly due to the limited number of cases among the individual medical centers worldwide.

Duodenal perforations are difficult to diagnose during the ERCP procedure because they occur in the lateral wall of the duodenum by the side-view endoscope (Fig. 3). Also, the routine use of sedation during the procedure makes the diagnosis even more difficult because it masks the symptoms. Gastroenterologists worldwide are trained to inspect the circumference of the duodenum carefully with the side-view scope at completion of the ERCP for early identification of a perforation. If such a perforation is identified, either by direct vision or by contrast extravasation during the ERCP, then the algorithm in Fig. 4 is proposed.

In addition, physical examination of the patient's abdomen at full recovery from the sedation is important. Specific signs and symptoms suspicious of injury are epigastric pain, tenderness with or without peritoneal signs

(guarding, rebound tenderness), tympany at percussion, tachycardia, and fever, although the last two tend to be late findings. If the physical examination is indicative of perforation, then an early decision regarding operative or nonoperative treatment must be made.

A common finding in the current study, especially among those who presented soon after the ERCP, was abdominal tenderness, but not frank peritonitis. Leukocytosis and fever often were present, but they were most consistent with presentation 12 h or more after the completion of the ERCP. Tachycardia was a more consistent physical finding, but it may not be a reliable indicator because it can be caused by pain resulting from another etiology. As a result, the only finding that prompted immediate surgical exploration was peritonitis, usually with manifestation more than 24 h after the ERCP.

Patients without peritoneal signs routinely underwent radiologic studies to confirm or exclude the suspicion of duodenal perforation. A supine and upright abdominal radiograph usually was advocated as a first investigative study. The lack of intraperitoneal air or the presence of only retroperitoneal air indicated a controlled or sealed perforation and could allow for conservative management consisting of bowel rest, nasogastric tube decompression of the stomach, broad-spectrum intravenous antibiotics, and serial physical examinations of the abdomen at frequent intervals. However, if clear peritoneal signs were evident, then operative intervention was required.

In the event that the abdominal radiograph showed free intraperitoneal air, computed tomography with oral water-soluble contrast (gastrografin) was helpful. Extravasation of the contrast in the intraabdominal cavity or the presence of fluid indicated surgical exploration, whereas lack of extravasation could permit conservative treatment (Fig. 4).

The extent of the operation was proportional to the degree of injury and the intraabdominal contamination. Extensive drainage or debridement together with primary closure for the defect with an omental patch gave the best results. This procedure was completed in most cases together with pyloric exclusion and gastrojejunostomy.

The two basic principles of surgical therapy are repair of the leak with diversion of the gastric contents and control for the source of the sepsis by means of external drainage. Gastric diversion also helps to prevent activation of pancreatic exocrine enzymes [10].

Most authors in the past have based their selection of the optimal treatment method mainly on the type of the perforation [2, 5, 11]. Stapfer et al. [5] routinely advocated surgical management for perforations of the lateral and medial duodenal wall and for peri-vaterian and ductal injuries if there was extensive free intraperitoneal air, whereas the finding of only retroperitoneal air justified conservative management (Table 1).

On the other hand, Assalia et al. [12] believed that classifications of ERCP-related duodenal perforations should be viewed as a general predictor of the treatment method and should not exclusively drive the surgeon's decision-making process. In this case series, the patients were treated according to predetermined guidelines, with the results supporting the opinion that the clinical condition of the individual patient and the radiologic findings, together with the radiologic findings, should allow for appropriate selection of patients to receive surgery or conservative management.

In conclusion, clinical and radiographic features can be used to determine the surgical or conservative treatment of ERCP-related duodenal perforations, whereas patient age and intraoperative findings can determine the final outcome and morbidity or mortality. The interval between the perforation and the operation is of great significance, with the mortality increasing dramatically in the case of late surgical management (>24 h). The optimal operation for ERCP-related duodenal perforations appears to be primary repair and duodenal diversion with gastrojejunostomy and pyloric exclusion. However, if the perforation is noted and managed early, primary repair without diversion has similar results, especially if there is minimal contamination of the abdominal cavity with enteric contents.

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