

## Endoscopic retrograde cholangiopancreatography in pancreatic and biliary tract disease in Korean children

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### Abstract

**AIM:** To assess the indications, findings, therapeutic procedures, safety, and complications of endoscopic retrograde cholangiopancreatography (ERCP) performed in Korean children.

**METHODS:** The demographic characteristics, indications for ERCP, findings, therapeutic procedures, and complications of 122 pediatric patients who underwent 245 ERCs in the Asan Medical Center between June 1994 and March 2008 were investigated.

**RESULTS:** The mean age of the 122 patients was  $8.0 \pm 4.2$  years. Indications were biliary pathology in 78 (64.0%), pancreatic pathology in 43 (35.2%), and chronic abdominal pain in one. Biliary indications included choledochal cysts in 40, choledocholithiasis in 24, suspected sclerosing cholangitis in 8, trauma in 2, and other conditions in 4. Pancreatic indications included

acute pancreatitis in 7, acute recurrent pancreatitis in 11, chronic pancreatitis in 20, trauma in 3, and pancreatic mass in 2. Of the 245 ERCs, success rate was 98.4% and 190 (77.6%) were for therapeutic purposes, including endoscopic nasal drainage (51.8%), biliary sphincterotomy (38.0%), pancreatic sphincterotomy (23.3%), stent insertion (15.1%), stone extraction (18.8%), and balloon dilatation (11.0%). Complications were post-ERCP pancreatitis in 16 (6.5%), ileus in 23 (9.4%), hemorrhage in 2 (0.8%), perforation in 2 (0.8%), sepsis in 1 (0.4%), and impacted basket in 1 (0.4%). There were no procedure-related deaths, and most complications improved under supportive care.

**CONCLUSION:** This study showed that there is a high incidence of choledochal cyst and diagnostic and therapeutic ERCP for the management of various biliary and pancreatic diseases was safe and effective in Korean children.

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**Key words:** Endoscopic retrograde cholangiopancreatography; Pancreatic diseases; Biliary tract diseases; Choledochal cyst; Pancreatitis; Pediatrics

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### INTRODUCTION

Endoscopic retrograde cholangiopancreatography (ERCP) is

a standard diagnostic and therapeutic modality for pancreaticobiliary diseases in adults<sup>[1]</sup>. Its standard use in children, however, has been limited by technical difficulties, low incidence of pancreaticobiliary disease, and lack of knowledge of ERCP by pediatric surgeons and pediatricians<sup>[2]</sup>. Pediatric ERCP is used as a therapeutic tool in addition to its diagnostic applications<sup>[3,4]</sup>. Regional differences in indications have been observed for pediatric ERCP<sup>[3-7]</sup>. Although the frequency of choledochal cysts is higher in Asian than in Western populations, there have only been a few studies of pediatric ERCP in Asian countries, with each involving small numbers of patients<sup>[5,7]</sup>. We therefore describe our experience in performing 245 ERCPs in 122 Korean children with pancreatobiliary diseases, focusing on the presenting diseases, diagnostic and therapeutic efficacy, and safety.

## MATERIALS AND METHODS

Between June 1994 and March 2008, 122 children (mean age,  $8.0 \pm 4.2$  years; range, 1 month to 16 years) underwent 245 ERCPs at the Asan Medical Center, Seoul, Korea. Of these 122 patients, 52 were boys and 70 were girls. We retrospectively reviewed the computerized hospital records of all patients to determine indications for ERCP, success of the procedure, diagnostic findings, therapeutic procedures, and complications. We also reviewed the basic characteristics of patients and the types of sedation used. Indications for ERCPs included biliary disease, pancreatic disease, and recurrent abdominal pain. ERCP was performed by standard techniques, using either a conventional adult duodenoscope (JF: Olympus America Inc.), a therapeutic duodenoscope (TJF: Olympus America Inc.), Pediatric duodenoscope (PJF-7.5E: Olympus America Inc.). The first few ERCPs were supervised by an adult gastroenterologist, with most subsequent procedures were performed by a pediatrician alone, except for some complicated cases. Informed, written consent was obtained from the parents of all patients, and this study was approved by our Internal Review Board. All ERCPs were performed under general anesthesia or deep sedation (midazolam, ketamine, and fentanyl). Successful ERCP was defined as cannulation of the bile duct or pancreatic duct along with completion of any planned diagnostic study or therapeutic procedure. Post-ERCP pancreatitis was defined as pancreatic abdominal pain with serum amylase/lipase elevated to over 3 times the upper normal limit.

## RESULTS

During the 14-year time period, we performed 245 ERCPs, including 55 (22.4%) diagnostic and 190 (77.6%) therapeutic procedures, on 122 children. Sixty-seven ERCPs (27.3%) were performed under general anesthesia and 178 (72.7%) under deep sedation. Of these 245 procedures, 241 (98.4%) resulted in successful cannulation. There were 78 (64.0%) patients with biliary indications,

Table 1 Indications for ERCP in 122 children *n* (%)

Indications	No. of patients	No. of procedures
Biliary indication	78 (64.0)	103 (42.0)
Choledochal cyst	40 (32.8)	60 (24.5)
Choledocholithiasis	24 (19.7)	27 (11.0)
Suspected sclerosing cholangitis	8 (6.6)	8 (3.3)
Trauma	2 (1.6)	4 (1.6)
Biliary complication after liver transplantation	2 (1.6)	2 (0.8)
Biliary stenosis after operation	1 (0.8)	1 (0.4)
Biliary atresia	1 (0.8)	1 (0.4)
Pancreatic indication	43 (35.2)	141 (57.6)
Acute pancreatitis	7 (5.7)	10 (4.1)
Acute recurrent pancreatitis	11 (19.7)	23 (9.4)
Chronic pancreatitis	20 (16.4)	102 (41.6)
Pancreatic mass	2 (1.6)	2 (0.8)
Trauma	3 (2.4)	4 (1.6)
Chronic abdominal pain	1 (0.8)	1 (0.4)
Total	122	245

ERCP: Endoscopic retrograde cholangiopancreatography.

43 (35.2%) with pancreatic indications, and one (0.8%) with chronic abdominal pain (Table 1).

### Biliary indications

The most common biliary indication was choledochal cyst (CC), also known as congenital biliary dilatation. Table 2 shows the diagnostic findings in 78 patients with biliary indications. Forty patients with choledochal cysts underwent 60 ERCPs. Choledochal cysts were divided to 4 types using the Todani classification<sup>[8]</sup>. There were 14 patients with type I c, 2 with type III, and 24 with type IV CC. Thirty of these 40 patients had bile duct stones (choledocholithiasis) and 9 had common bile duct (CBD) strictures. Anomalous union of the pancreaticobiliary duct (AUPBD) was detected in 25 patients with CC. Endoscopic sphincterotomy was performed on 2 CC type III patients without recurrence. Patients with acute biliary pancreatitis and choledocholithiasis underwent various procedures, including endoscopic sphincterotomy, endoscopic nasal biliary drainage, and stone extraction. ERCPs were performed for preoperative treatment or evaluation, except for one patient who underwent ERCP after surgery for removal of remnant stones. Two patients (one type Ic and one type IVa), who showed much improved bile duct dilatation after ERCP, underwent laparoscopic cholecystectomy. Eight type Ic patients and 18 type IVa patients underwent Roux-en-Y hepaticojejunostomy after acute pancreatitis or acute biliary colic had resolved. One type IVa patient showed improved bile duct dilatation and cholestasis after ERCP, but died of an underlying disease, acute myeloid leukemia. Ten patients, 6 of type Ic and 4 of type IVa, are well, with mild dilatation of the CBD; surgery is planned for each. Two patients with type I CC showed improved dilatation, with the disappearance of CC confirmed by ultrasound.

Of the 24 patients with choledocholithiasis, 19

**Table 2** Diagnostic findings in 78 patients with biliary indications

Diagnosis (number of patients)	ERCP findings							
	Bile duct stone	CBD dilatation	CBD stricture	SC	Bile leak	AUPBD	Normal	Failure
Choledochal cyst ( <i>n</i> = 40)	30	38	9			25		1
Choledocholithiasis ( <i>n</i> = 24)	24	19	4			6		
Suspected SC ( <i>n</i> = 8)				4			4	
Trauma ( <i>n</i> = 2)			1		1			
Biliary complication after liver transplantation ( <i>n</i> = 2)					1		1	
Biliary stenosis after operation ( <i>n</i> = 1)			1					1
Biliary atresia ( <i>n</i> = 1)								1

CPD: Common bile duct; SC: Sclerosing cholangitis; AUPBD: Anomalous union of the pancreaticobiliary duct.

**Table 3** Diagnostic findings in 43 patients with pancreatic indications

Diagnosis (number of patients)	ERCP findings									
	PD dilatation	PD stenosis	Pancreaticolith	PD anomaly	AUPBD	Pancreas divisum	Trans-section of pancreas	Other	Normal	Failure
Acute pancreatitis ( <i>n</i> = 7)		1	1					1 CBD stenosis	4	
Acute recurrent pancreatitis ( <i>n</i> = 11)		2		2	2	2			3	
Chronic pancreatitis ( <i>n</i> = 20)	16	11	6	1	1	8				1
Pancreatic mass ( <i>n</i> = 2)	1							1 SPPN		
Trauma ( <i>n</i> = 3)							3			

SPPN: Solid pseudopapillary neoplasm; PD: Pancreatic duct.

showed CBD dilatation, however they did not show the evidence of CC and 4 had CBD stricture. AUPBD was found in 6 patients. Only 2 patients had specific hematologic diseases, one each with hereditary spherocytosis and glucose-6-phosphate dehydrogenase (G6PD) deficiency. Eight patients underwent ERCP for suspected sclerosing cholangitis, but only 4 showed evidence of sclerosing cholangitis, with the other 4 showing no abnormalities. Two patients who experienced blunt trauma underwent ERCP; one had intrahepatic bile duct leakage and one had a benign CBD stricture. Two patients were suspected to have biliary complications after liver transplantation; one showed a bile leak and the other showed no abnormal findings. One patient had a CBD stricture after resection of a duodenal web. Cannulation was unsuccessful in one patient with biliary atresia.

**Pancreatic indications**

The most common pancreatic indication was chronic pancreatitis, observed in 20 patients. Other pancreatic indications included acute pancreatitis (7 patients), acute recurrent pancreatitis (11 patients), pancreatic mass (2 patients), and trauma (3 patients). Table 3 shows the diagnostic findings in 43 patients with pancreatic indications. Pancreas divisum was observed in 10 patients, 7 of whom underwent repeated endoscopic minor pancreatic sphincterotomy because of minor duct stenosis. Of the 8 patients with acute pancreatitis, 4 showed normal findings, and one each showed evidence of pancreatic duct stenosis, pancreaticoliths, and CBD stenosis. ERCP on a boy aged 9 years, with pancreatitis and a suspected

intraductal papillary mucinous neoplasm, showed a bulge of the ampulla of Vater and large amounts of sticky mucinous materials, but histology after surgery showed only chronic pancreatitis. Of the 11 patients with acute recurrent pancreatitis, 2 showed pancreatic duct stenosis, 2 showed pancreatic duct anomalies, 2 had AUPBD, 2 had pancreas divisum, and 3 showed normal findings. Preoperative ERCP on 2 patients with pancreatic masses showed that one had a retroperitoneal teratoma with extrinsic distal CBD compression, and the other had a solid pseudopapillary neoplasm in the tail of the pancreas with abrupt interruption of the distal pancreatic duct. Three patients with traumatic pancreatitis showed transection of the pancreas.

**Abdominal pain**

ERCP showed that one patient with recurrent abdominal pain had a normal anatomy of the pancreaticobiliary system. We did not perform the sphincter of Oddi manometry because of its technical problems and difficulties of translation with no definite normal range in children with ERCP.

**Therapeutic procedures**

Of the 245 ERCPs, 127 (51.8%) were for endoscopic nasal drainage, 93 (38.0%) were for biliary sphincterotomy, and 57 (23.3%) were for pancreatic sphincterotomy. Stents were inserted during 37 procedures (15.1%), stone extraction was achieved during 46 (18.8%), balloon dilatation of a strictured CBD or pancreatic duct was performed in 27 (11.0%). Endoscopic drainage of a

Table 4 Therapeutic procedures during 245 ERCPs

Type of endoscopic therapy	Number of procedures (% of 245 cases)
Endoscopic nasal drainage	127 (51.8)
Biliary sphincterotomy	93 (38.0)
Pancreatic sphincterotomy	57 (23.3)
Stone extraction	46 (18.8)
Stent insertion	37 (15.1)
Balloon dilatation	27 (11.0)
Endoscopic drainage of pseudocyst	2 (0.8)

pseudocyst complicating acute pancreatitis was performed in 2 patients (Table 4). One had a pneumoperitoneum, which was improved by supportive care with nil by mouth. In early times, we placed the nasobiliary drain in patients but nowadays we prefer to insert 5 to 7 Fr plastic stents depending on age for biliary obstruction or septic cholangitis.

### Complications

Post-ERCP pancreatitis was observed after 16 procedures (6.5%), and post-ERCP ileus after 23 (9.4%). In 16 cases of post-procedure pancreatitis, there were 4 mild, 10 moderate, 2 severe cases and all cases developed early (a few hours) after ERCP by Cotton's definition<sup>[9]</sup>. Two patients had major episodes of hemorrhage at the sphincterotomy site, requiring red blood cell transfusion. These patients underwent additional ERCPs and epinephrine injections. Intestinal perforation developed in 2 patients. One, with perforation of the CC wall and bile leakage, underwent an emergency operation, and the other, with perforation of the posterior duodenal wall, improved following supportive care. Culture-proven sepsis was observed in one patient and an impacted basket in one. In the latter, the basket was broken during the removal of a large, firm, pancreatic duct stone, which was being managed by extracorporeal shock wave lithotripsy followed by endoscopic removal of the remaining basket with stones. There was no procedure-related mortality in our patients (Table 5).

## DISCUSSION

ERCP has become a new diagnostic and therapeutic modality in children with pancreaticobiliary disease<sup>[3,10]</sup>. Almost all studies, however, have been performed on Western children, with few in Asian children. The most common indications for ERCP in Western children are choledocholithiasis and pancreatitis<sup>[3,10]</sup>. Indications differ, however, in Asian countries<sup>[5,7,11]</sup>. For example, the most common indication in Saudi Arabia was choledocholithiasis in patients with sickle-cell anemia<sup>[11]</sup>, whereas the most frequent indication in Japan and India was CC<sup>[5,7]</sup>. As in Japan, the most common indication in our group of 122 Korean children was CC. Almost all patients with CC had acute biliary pancreatitis or obstructive jaundice with stone/sludge; these patients were treated by endoscopic sphincterotomy, stone removal, endoscopic nasal biliary

Table 5 Incidence of complications following 245 ERCPs

Type of complications	Number of episodes (% of 245 cases)
Pancreatitis	16 (6.5)
Ileus	23 (9.4)
Hemorrhage	2 (0.8)
Perforation	2 (0.8)
Sepsis	1 (0.4)
Impacted basket	1 (0.4)

drainage (ENBD), or stent insertion. We previously reported that biliary pancreatitis is a common cause of acute pancreatitis in Korean children and that intervention with ERCP may be a useful treatment modality<sup>[12]</sup>. We found that ERCP helped to improve pancreatitis and associated inflammation, and offered relief of acute symptoms. For this purpose, we performed ENBD or indwelling stent implantation prior to operation of CC. ERCP-guided interventions in patients with complicated CCs, combined with AUPBD, have been reported to be helpful in refractory cases and to optimize patient condition prior to definitive surgery<sup>[13-16]</sup>. In addition to symptomatic relief, preoperative ERCPs also may provide surgeons with more precise anatomical knowledge of the bile duct and the pancreatic duct, which may help during total surgical excision, the optimal treatment for CC. Surgeons require information on the length of the distal narrow portion of the dilated bile duct and clear visualization of its confluence with the pancreatic duct<sup>[7]</sup>. In addition, ERCP has been reported to be superior to magnetic resonance cholangiopancreatography (MRCP) in evaluation of minor ductal anomalies<sup>[17]</sup> although MRCP is a noninvasive, safe technique. Endoscopy is the treatment of choice for uncomplicated choledochocoele (type III)<sup>[18]</sup>, and we treated two such patients with endoscopic sphincterotomy.

A total of 33 patients had AUPBD, including 25 with CC, 6 with choledocholithiasis, and 2 with acute recurrent pancreatitis. Thirty patients underwent endoscopic sphincterotomy and drainage. The incidence of AUPBD in Asian patients undergoing ERCP has been reported to be 1.5%-2.6%<sup>[19]</sup>. These patients require surgical treatment, because biliary cancer can arise from chronic inflammation of the bile duct because of the reciprocal regurgitation of pancreatic and bile juice reflux, although endoscopic sphincterotomy can be considered for most symptomatic patients<sup>[16]</sup>. Using an AUPBD puppy model, sphincteroplasty was shown to be effective in reducing bile duct dilatation and mucosal hyperplasia<sup>[20]</sup>. Prophylactic cholecystectomy is considered the best treatment option for patients with AUPBD but without bile duct dilatation<sup>[21]</sup>. We found that bile duct dilatation improved in 2 such patients, both of whom underwent laparoscopic cholecystectomy.

Choledocholithiasis is the second most frequent biliary indication for ERCP. Such patients were treated by endoscopic sphincterotomy and stone removal with basket/balloon extraction. Only 2 patients had hematologic diseases: hereditary spherocytosis and G6PD deficiency.

ERCP is considered the treatment of choice in children with CBD stones<sup>[11]</sup>. One patient with both CBD and gallbladder stones underwent endoscopic CBD stone removal and subsequent laparoscopic cholecystectomy for gallbladder stones or sludges. Therefore, surgery was minimally invasive.

The most common pancreatic indication in our study was chronic pancreatitis, observed in 20 patients who underwent 102 ERCPs (40.8%; mean 5.2 ERCPs per patient). These patients underwent repeated sphincterotomy with nasal drainage, and stents were placed in 9 patients.

Pancreas divisum was observed in 10 patients with pancreatic indications, 8 with chronic pancreatitis and 2 with acute recurrent pancreatitis. ERCP is a useful diagnostic and therapeutic procedure in patients with pancreas divisum<sup>[22]</sup>. Minor papilla sphincterotomy and stent insertion can decrease the rate of recurrent acute pancreatitis<sup>[23]</sup>. We performed minor duct sphincterotomy and inserted stents in 7 of these 10 patients, without specific complications.

Other pancreatic indications included suspected intraductal mucinous pancreatic adenoma, which was revealed to be chronic pancreatitis, pancreatic duct lesions related to a pancreatic mass, and transected pancreas arising from trauma. Although recurrent abdominal pain has been reported to be a common indication for ERCP<sup>[3]</sup>, we found that only one patient underwent ERCP for suspected pancreatic abdominal pain and that, on ERCP, this patient showed normal findings.

Among the ERCP-associated procedures now becoming therapeutic options in children with pancreaticobiliary disease are sphincterotomy, balloon dilatation, stone extraction, stent insertion, and nasal drainage<sup>[2,3,6,10,11]</sup>. We also performed various therapeutic procedures (Table 4), almost all of which relieved acute symptoms, as well as revealing more exact anatomy to the pediatric surgeons.

ERCPs performed by expert endoscopists in children have been reported to have similar success rates and lower complication rates compared with ERCPs in adult patients<sup>[4]</sup>. Although we experienced some complications, there was no procedure-related mortality. Post-ERCP pancreatitis occurred after 16 ERCPs (6.5%) however all showed improvement with supportive care. The incidence of pancreatitis following ERCPs in adults has been reported to be 2.6%-13.1%<sup>[24-26]</sup>.

In conclusion, diagnostic and therapeutic ERCPs were performed safely and effectively in Korean children for the management of various biliary and pancreatic diseases. Pediatricians and pediatric surgeons, especially those working in Asian countries, should become more familiar with ERCP as a diagnostic and therapeutic modality, as Asia has a high incidence of CCs and anomalous union of the pancreaticobiliary duct.

application of ERCP in therapeutic purposes besides diagnostic evaluations in pediatric patients.

### Research frontiers

This study is the first report on ERCP in a large number of Korean pediatric patients.

### Innovations and breakthroughs

The authors demonstrated that diagnostic and therapeutic ERCPs were performed safely and effectively for managements of various biliary and pancreatic diseases.

### Applications

ERCP can be considered as an effective and safe modality in children with pancreaticobiliary disease.

### Peer review

In this study, ERCPs were performed in a large number of Korean children with various biliary and pancreatic diseases safely and effectively. Pediatricians and pediatric surgeons, especially those working in Asian countries, should become more familiar with ERCP as a diagnostic and therapeutic modality, as Asia has a high incidence of CCs and anomalous union of the pancreaticobiliary duct.

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## COMMENTS

### Background

Endoscopic retrograde cholangiography (ERCP) is a standard diagnostic and therapeutic modality for pancreaticobiliary disease. Recent reports showed the

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