



Success and safety of endoscopic retrograde cholangiopancreatography in children^{☆,☆☆}



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ABSTRACT

Purpose: Despite its diagnostic and therapeutic utility, endoscopic retrograde cholangiopancreatography (ERCP) is underutilized in children.

Methods: Patients younger than 18 years undergoing ERCP from 2000 to 2014 at a children's hospital were identified. Patient characteristics and outcomes were evaluated.

Results: Overall, 215 ERCPs (78% therapeutic) were performed in 184 patients. Our cohort was 67% female, with a median age (IQR) of 14 (8) years. Common indications were choledocholithiasis, pancreatitis, sclerosing cholangitis, and postoperative complication. ERCP was performed with an adult duodenoscope in 96% of cases and with a pediatric duodenoscope in the remainder. Patients requiring a pediatric scope ranged in weight from 4.3 to 22.8 kg, with ages from 2 months to 6 years. Cannulation was successful in 97% of cases. Findings included bile duct (BD) stones, BD dilatation, sclerosing cholangitis, BD stricture, pancreatic duct (PD) disruption, choledochal cyst, pancreas divisum, and BD leak. The most common therapeutic techniques were sphincterotomy, stone extraction, and stent. Complication rate was overall 10% with no deaths. On multivariate analysis, PD cannulation was associated with pancreatitis (OR 3.48), while age <4 years (10.7), male gender (12.8), and precut sphincterotomy (31.3) were associated with hemorrhage (all $p < 0.05$).

Conclusion: ERCP can be performed successfully and safely in children with complication rates comparable to those in adults. The type of cannulation and patient age are independent risk factors for complications.

Level of evidence: Treatment study—IV.

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Endoscopic retrograde cholangiopancreatography (ERCP) is a therapeutic and diagnostic procedure used in the evaluation of a variety of biliary and pancreatic disorders. Such disorders have historically been difficult to treat and are associated with poor outcomes. In 1968, McCune et al. [1] first introduced ERCP as a diagnostic technique to visualize abnormalities in the common bile duct, pancreatic duct, and ampulla. Endoscopy with fluoroscopy is utilized to visualize and biopsy abnormalities of the pancreaticobiliary system, as well as to relieve ductal obstruction, fluid drainage, and stent placement.

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ERCP is performed in adults in order to treat tumors, pancreatitis, biliary disease, and infections. The introduction of magnetic resonance cholangiopancreatography (MRCP) has replaced ERCP as the standard in diagnosing conditions such as choledocholithiasis, bile duct stenosis, and pancreatitis [2,3]. Despite its benefits, MRCP is not therapeutic and treatment must still be addressed by alternative means.

In the United States, it is estimated that of the 500,000 ERCP cases performed in adults each year, 8% result in morbidity and 0.4% result in mortality [4]. Although the efficacy and safety of performing ERCP in adults have been demonstrated [1,5–9], questions regarding the safety of ERCP in children still remain. These revolve specifically around the comparison of rates of postprocedural complications such as pancreatitis, hemorrhage, and duodenal perforation as well as in the use of ERCP in smaller neonates [3,8,10–12]. We compiled a cohort of 215 pediatric ERCP procedures as part of a case series to further analyze the diagnostic and therapeutic utility of ERCP in children.

1. Materials and methods

All patients younger than 18 years undergoing ERCP from January 1, 2000 to December 31, 2014 at Holtz Children's Hospital, Miami, FL were

identified by retrospective chart review. All of the ERCP procedures were performed by a single, experienced surgical endoscopist trained in laparoscopic general surgery and advanced endoscopy. The adult duodenoscopes included the following: TJF-160F, with an outer diameter (OD) of 11.3 mm with a single 4.2 mm instrument channel, and JF-140F, with an OD of 11.0 mm with a single 3.2 mm biopsy channel. The pediatric duodenoscope used was PJF-160, with an OD of 7.5 mm with a single 2.0 mm biopsy channel. All devices were produced by Olympus America, Center Valley, PA.

Patient demographics, indications, use of imaging, procedure type, findings, prevalence and type of complications, and prevalence and types of related operations were evaluated. Multivariate analysis (MVA), in the form of binary logistic regression modeling, was used to identify determinants of postprocedural complications. All odds ratio (OR) values are presented with 95% confidence intervals. For reference, post-ERCP pancreatitis was defined as (1) new or worsened abdominal pain, (2) hospitalization ≥ 2 days, and (3) serum amylase ≥ 3 times upper limit of normal ≥ 24 h postprocedure. Significance for all analyses was determined at $p < 0.05$.

Approval was obtained from the institutional review board at the University of Miami Miller School of Medicine.

2. Results

Overall, 215 ERCPs were performed in 184 patients. Seventy-eight percent of cases were performed for therapeutic purposes, whereas the remaining 22% were for diagnostic indications. Of the cohort, 67% were female, and median age (IQR) was 14 (8) years. Many of the patients had ultrasonography (70%) or magnetic resonance cholangiopancreatography (43%), while 61% had related operations including biliary (45%), hepatic (14%) and pancreatic (2%) procedures before or after ERCP. Common indications included choledocholithiasis (50%), pancreatitis (14%), sclerosing cholangitis (13%), and postoperative complication (9%). For additional procedure details, see Table 1.

ERCP was performed with an adult duodenoscope in 96% of cases and with a pediatric duodenoscope in the remainder (4%). Patients requiring a pediatric scope ranged in weight from 4.3 to 22.8 kg, with ages ranging from 2 months to 6 years. Three infants younger than 1 year (2 months 3 days, 2 months 22 days, and 5 months 26 days) underwent the procedure, weighing 4.3, 6.5, and 6.9 kg, respectively—all of these were performed using the pediatric duodenoscope. Cannulation was successful in 97% of cases. A precut sphincterotomy, a technique used to incise the papilla prior to cannulation or guidewire introduction, was required in 4% of cannulations. Abnormal findings included bile duct (BD) stones ($n = 75$), BD dilatation ($n = 23$), sclerosing cholangitis ($n = 15$), BD stricture ($n = 14$), pancreatic duct (PD) disruption ($n = 9$), choledochal cyst ($n = 8$),

pancreas divisum ($n = 6$), and BD leak ($n = 5$). The most common therapeutic interventions were sphincterotomy (76%), stone extraction (56%), and stent (23%). The overall complication rate was 10%. Postprocedure pancreatitis occurred in 7% ($n = 15$), whereas hemorrhage occurred in 3% ($n = 6$), and duodenal perforation managed nonoperatively occurred in 0.4% ($n = 1$). No mortalities occurred during this study period. For additional procedure details, see Table 2.

A case of duodenal perforation occurred in a 5 year old patient weighing 19.9 kg, undergoing ERCP with an adult duodenoscope for recurrent pancreatitis because of pancreatic duct strictures. Multiple attempts were made to cannulate past an extremely small ampulla, all of which were unsuccessful, even after a sphincterotomy. She later developed persistent abdominal pain and subcutaneous emphysema, prompting a CT scan which demonstrated pneumoretroperitoneum. While the source was suspected to be the duodenum, an upper gastrointestinal series was unable to identify extravasation. The patient stabilized after nonoperative management in the intensive care unit and the pain resolved.

On multivariate analysis, PD cannulation was associated with pancreatitis (odds ratio [95% confidence interval], p -value: 3.48 [1.04, 11.6], $p = 0.042$). Age < 4 years (10.7 [1.10, 103], $p = 0.042$), male gender (12.8 [1.10, 149], $p = 0.042$), and precut sphincterotomy (31.3 [1.40, 700], $p = 0.030$) were all separately associated with hemorrhage. For a graphical representation of these determinants, see Fig. 1.

3. Discussion

Pancreatic and bile duct diseases lead to a substantial number of hospitalizations and surgical interventions in adults. The incidence of pancreaticobiliary problems in children, however, is less common. Although recent research has emerged in support of ERCP in pediatric cases [1,5–9], much of the research is extrapolated from small study populations. Our review of 215 ERCPs performed on 184 patients supports the notion that ERCP can be used as a safe and effective means of treatment in pediatric patients.

Although the protocol promulgated by the American Society of Gastrointestinal Endoscopy for the use of ERCP is specific to adults, the absence of consensus regarding the safety and indications of ERCP in the pediatric population has restricted the training of endoscopists for these cases. In our study, a surgical endoscopist who has performed approximately 1500 ERCPs in the adult population was successfully and

Table 1
Indications and procedures associated with endoscopic retrograde pancreatography in pediatric patients, 2000–2014 (total $n = 215$).

| Category | n (%) |
|--|-----------|
| Indication type | |
| Therapeutic | 168 (78%) |
| Diagnostic | 47 (22%) |
| Imaging studies | |
| Ultrasonound | 151 (70%) |
| Magnetic resonance cholangiopancreatography (MRCP) | 92 (43%) |
| Related surgical interventions | |
| Yes | 131 (61%) |
| Biliary procedure | 97 (45%) |
| Hepatic procedure | 30 (14%) |
| Pancreatic procedure | 4 (2%) |
| No | 84 (39%) |
| Indications | |
| Choledocholithiasis | 108 (50%) |
| Pancreatitis | 30 (14%) |
| Sclerosing cholangitis | 28 (13%) |
| Postoperative complications | 19 (9%) |

Table 2
Procedure details, findings, therapies, and complications associated with endoscopic retrograde pancreatography in pediatric patients, 2000–2014 (total $n = 215$).

| Category | n (%) |
|----------------------------|-----------|
| Procedure details | |
| Scope type | |
| Adult duodenoscope | 206 (96%) |
| Pediatric duodenoscope | 9 (4%) |
| Cannulation success | 209 (97%) |
| Precut sphincterotomy | 8 (4%) |
| Findings | |
| Bile duct stones | 75 (35%) |
| Bile duct dilatation | 23 (11%) |
| Sclerosing cholangitis | 15 (7%) |
| Bile duct stricture | 14 (7%) |
| Pancreatic duct disruption | 9 (4%) |
| Choledochal cyst | 8 (4%) |
| Pancreas divisum | 6 (3%) |
| Bile duct leak | 5 (2%) |
| Interventions | |
| Sphincterotomy | 163 (76%) |
| Stone extraction | 120 (56%) |
| Stent placement | 49 (23%) |
| Complications | |
| Pancreatitis | 15 (7%) |
| Hemorrhage | 6 (3%) |
| Duodenal perforation | 1 (0.4%) |

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