

# Endoscopic retrograde cholangiopancreatography in children: Retrospective series with a long-term follow-up and literature review

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## ABSTRACT

**Background/Aims:** To investigate the safety and long-term results of endoscopic retrograde cholangiopancreatography (ERCP) in children with a literature review.

**Materials and Methods:** All patients within the age range of 6-17 years who underwent ERCP between 1994 and 2014 at our institution were retrospectively evaluated.

**Result:** Twenty-four patients with a median age of 15 years underwent ERCP. Cannulation of the papilla was achieved in all patients (100%) without the use of needle-knife papillotomy. Before 1999, ERCP was used as a diagnostic method only in 7 patients (29%). In 17 (71%) patients, the procedure was used for therapeutic purposes. The indications were choledocholithiasis (10 cases, 42%), post-operative complications (5 patients, 21%), and recurrent pancreatitis (2 cases, 8%). In 2 patients (8%), the therapeutic effect was not achieved, thus requiring subsequent operations. There were no major complications. Mild pancreatitis occurred in only 1 patient (4%). Long-term follow-up information was obtained in 16 (67%) patients (median, 18 years; range, 3.5-22.5 years), and no long-term complications were detected.

**Conclusion:** Endoscopic retrograde cholangiopancreatography is a valuable tool in the diagnosis and treatment of pancreatobiliary disorders in the pediatric population. Large-scale studies are required to create evidence-based guidelines specific to children.

**Keywords:** Endoscopic retrograde cholangiopancreatography, pediatric endoscopic retrograde cholangiopancreatography, sphincterotomy, stone extraction, balloon dilatation

## INTRODUCTION

Since the introduction of endoscopic retrograde cholangiopancreatography (ERCP) by McCune et al. (1) in 1968, it remains an irreplaceable tool in the diagnosis and treatment of biliary and pancreatic disorders. Although its applicability in pediatric patients was shown as early as 1976 by Waye (2), the procedure has only become more common in the recent years. This may be explained by the fact that ERCP, an invasive method, carries a considerable risk for severe complications and even death. However, there is a rising number of studies and experiences in the pediatric population. While the overall post-ERCP morbidity and mortality rates of 6.9% and 0.3% were reported in adult population (3,4), a recent systematic review identified a comparable 6% (95% CI 4%-8%) complication rate in pediatric patients (5).

Unfortunately, there is no unified algorithm for the application of ERCP in children. Thus, guidelines established for adults are being used. Despite the similarities between both populations, the indications and clinical requirements are often different in children. This requires focusing the efforts on establishing specific indications, preparing the procedure, and equipment usage as well as technical and clinical requirements for children.

Although an increasing number of studies have confirmed the efficacy of ERCP in children (2,6-11), questions regarding safety remain unanswered. Furthermore, data on long-term follow-up are extremely limited. The goal of our study was to investigate the safety and long-term results of this procedure in our series and to review the literature.

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## MATERIALS AND METHODS

All patients within the age range of 6-17 years who underwent ERCP between 1994 and 2014 at our institution were retrospectively evaluated. Informed consent for the procedure was obtained from the parents of each patient.

The charts were reviewed for data regarding demographics, indications, type of anesthesia, success rate, diagnosis, need for additional procedures, and early and long-term outcomes. The procedures were divided into diagnostic (use of cholangiopancreatography as the final diagnostic tool) or therapeutic (ERCP combined with sphincterotomy (ST), stone extraction, stent placement, or dilatation of stenotic regions) purposes. All the procedures were performed by a single trained surgeon-endoscopist; however, each step of the process (preparations, procedure, indications, and subsequent treatment) was performed in close collaboration with pediatric surgeons and gastroenterologists. Standard adult-sized duodenoscopes (Fujinon) were used. All patients underwent deep sedation under the supervision of an anesthesiologist, and constant cardiovascular and respiratory monitoring (intubation was not necessary for any of the patients in this group) was performed. Children were kept nil by mouth for 8 hours before the procedure, which was carried out early in the morning. Diet was resumed at the night of the intervention according to the clinical conditions of the patient. Failure was defined as 1) inability to cannulate the papilla and performing cholangiography and 2) inability to achieve therapeutic effect leading to subsequent surgery. The follow-up period was at least 3 years.

## RESULTS

Twenty-four patients (17 females and 7 males) with a median age of 15 years (range, 6-17) underwent ERCP (Table 1). Cannulation of the papilla was achieved in all patients (100%) without the use of any needle-knife papillotomy. More than one procedure was needed in 2 patients; one with pancreas divisum and the other with a

retained common bile duct (CBD) stone following laparoscopic cholecystectomy in whom the attempt for endoscopic removal was initially unsuccessful. Both patients had anatomical variations, which may explain the technical difficulties encountered.

As a diagnostic method only, ERCP was used in 7 patients between 1995 and 1999. The indications were: 1) suspicion of CBD stones (3 patients); 2) primary sclerosing cholangitis (1 patient); 3) choledochocoele (Alonso-Lej type II, 1 patient); 4) pancreatic pseudocyst with no gallstones or pathological findings in the ductal system (1 patient); and 5) recurrent cholangitis in a patient with a known alveolar hepatic disease infiltrating the liver hilum-multiple stenotic regions in the intra and extrahepatic biliary tree.

In the remaining 17 patients, the procedure was used for both diagnostic and therapeutic purposes. The most common indication was choledocholithiasis, which was present in 10 cases (9 females and 1 male). The main clinical manifestation was intermittent jaundice or symptoms of acute cholangitis. One patient presented with biliary pancreatitis. Two patients were referred for ERCP after laparoscopic cholecystectomy. One of these cases was a 12-year-old girl who had undergone preoperative ERCP and ST with the extraction of a stone from the CBD, followed by laparoscopic cholecystectomy in 2001. She was referred to our institution 50 days after surgery due to recurrent symptoms of CBD obstruction. In the first ERCP attempt, cannulation was unsuccessful, and the procedure was discontinued only to be completed on the next day. Re-ST was performed and a retained calculus was extracted. The other patient had developed abdominal pain with a mild elevation of bilirubin and gamma-glutamyl transferase levels 2 months after undergoing laparoscopic cholecystectomy. A CBD stone was identified and successfully removed using ERCP and ST.

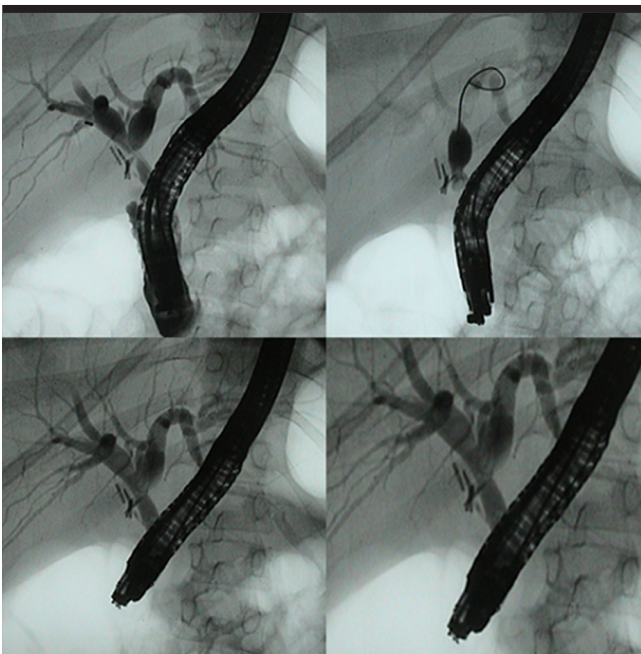
**Table 1.** Patient demographics, indications, and results

	Diagnostic procedure (1994-1999)		Therapeutic procedure (1994-2014)						Total
			Choledo- cholitiasis		Postoperative complications		Recurrent pancreatitis		
	M	F	M	F	M	F	M	F	
Total no. of patients (%)	7 (29%)		10 (42%)		5 (21%)		2 (8%)		24 (100%)
Sex	M	F	M	F	M	F	M	F	7M/17F
Successful cannulation	2	5	1	9	3	2	1	1	24 (100%)
Successful therapeutic procedure	-	-	1	8	-	7	-	1	17 (71%)
Unsuccessful therapeutic procedure with a need of subsequent operation	-	-	-	1	-	-	1	-	2 (8%)

The youngest patient in our study was a 6-year-old girl who had biliary dilatation (12 mm) and two stones in the CBD. ERCP and ST were performed with the subsequent removal of the calculus. Such pathology was highly atypical at such a young age.

The therapeutic effect was not achieved in only one patient with a CBD stone of 2-cm diameter. Mechanical lithotripsy is commonly used in adult patients; however, it was technically challenging in this patient due to limited space for maneuvering the duodenoscope and lithotripter in the duodenum. The procedure was abandoned and the patient was operated upon.

Postoperative complications necessitating an ERCP were separately evaluated in our study. In this group, we included 1 patient with postlaparoscopic cholecystectomy stenosis of the CBD and 4 patients with biliary leakage following surgery for hepatic hydatid disease. In the first case, elevations of liver enzymes and white blood count (WBC) were observed in a 10-year-old girl who had undergone laparoscopic cholecystectomy. Early ERCP was performed 72 hours after the operation, and stenosis of the bile duct at the level of the cystic duct stump due to "pincement lateral" from a cystic stump clip was found (Figure 1). Balloon dilatation was performed and the clip narrowing the bile duct was dislodged.



**Figure 1.** A cystic stump clip narrowing the bile duct with subsequent balloon dilatation and postprocedural cholangiography

Four patients, 3 males and 1 female, aged between 14 and 17 years had bile leakage from their abdominal drains following operations for hepatic hydatid disease with daily outputs between 100 and 750 mL. After performing an endoscopic ST, leakage ceased in all of them without the need for any additional intervention.

Recurrent attacks of pancreatitis were the indication for ERCP in 2 patients. In the first case of a 13-year-old boy, pancreas divisum was found to be the cause. ST of the minor papilla was performed. Unfortunately, the effect of the procedure was not permanent, and the patient underwent surgery. The second patient was a 15-year-old girl with dilatation of the CBD and the pancreatic ducts. No specific pathology was identified during ERCP. ST was done to eliminate dysfunction of the sphincter of Oddi. Recurrent pancreatitis was not observed during 7 years of follow-up.

There were no major complications in this series. In only 1 patient (4%), the elevation of amylase and WBC and complaints of abdominal pain were detected. The amylase levels normalized on the third day following treatment with intravenous fluid therapy, spasmolytic medication, and proton pump inhibitors. In all the other patients, postprocedural period was uneventful.

Long-term follow-up information was obtained in 16 (67%) patients (median, 18 years; range, 3.5-22.5 years) and no long-term complications were detected.

## DISCUSSION

Endoscopic retrograde cholangiopancreatography is a relatively rare procedure in children compared with the adult population. This may be partly due to a relatively low rate of pancreatobiliary disorders in the pediatric age group, as well as technical difficulties and insufficient data regarding indications and safety algorithms (7,12,13). The pediatric gastroenterology departments often do not have sufficient experience in this demanding procedure. It has been suggested that a minimum of 200 ERCPs are necessary to achieve competency and subsequently more than 50 cases per year to remain so (13,14). Literature data on pediatric ERCP mostly comprise series performed by experienced endoscopists working with adult populations. To the best of our knowledge, only 2 reports were found in the literature where pediatric gastroenterologists had performed the procedures (11,15).

The pure diagnostic value of ERCP has significantly decreased with the development of magnetic resonance

cholangiopancreatography (MRCP) (16,17). It has replaced ERCP in the assessment of choledochal cysts, recurrent pancreatitis, primary sclerosing cholangitis, and biliary stenosis (12,18). Currently, ERCP should be mainly restricted to therapeutic procedures. This was also reflected in our study, as a purely diagnostic procedure was not performed after 1999. After that year, all procedures were carried out with a therapeutic intent, which also confirms the efficacy of MRCP as a diagnostic tool.

In the literature, recurrent pancreatitis was the most common indication for ERCP in children (4,5,6,12,13,16). Gallstone disease was the indication in only 26% (10,12). This was in contrast with the findings of our study, because the most common indication for the procedure in our group of patients was choledocholithiasis and post-operative complications, such as bile leakage or biliary obstruction. Although ERCP was successful (cannulation of the papilla) in all patients in our study group, the reported success rate in the literature ranges from 89.5% to 97.5% (9,12). Difficulty in cannulation was only encountered in 2 of our patients; however, second attempts on the next day were successful in both. Anatomical abnormalities, previous surgery, and inadequate sedation are reported as factors leading to difficulties (19).

Although there were no neonates in our study group, it is crucial to emphasize the importance of ERCP as a diagnostic entity in cases with biliary atresia. In the literature, it has been reported that ERCP can rule out the need for surgery in 18%-44% of the patients (17,20,21). However, appropriate pediatric endoscopes and experience are necessary for assessing such a group of patients.

Deep sedation and cardiorespiratory monitoring were performed by an anesthesiologist during the procedure in this series. The exclusive use of moderate sedation has been described (22), but data showing that this can lead to premature discontinuation of the procedure or conversion to general anesthesia in approximately 7% of the cases are also reported (6). Furthermore, the soft-walled trachea in small children may be compressed by the duodenoscope, whereas the typical prone position during ERCP may additionally compromise chest excursion. Because subsequent airway rescue may be technically challenging, all the risk factors must be considered together with the anesthesiology team prior to the procedure.

The reported morbidity rate in the literature for the pediatric population ranges between 4.8% and 9.7% (4% in our series) (10,11,12,16). The common complications are

pancreatitis (3.0%-9.7%), hemorrhage (0.7%), and perforation (0.4%) (6,10,16,17,23). Postprocedural pancreatitis is the most common complication. Studies on adults have demonstrated that the routine use of rectal indomethacin or prophylactic pancreatic stenting in high-risk patients significantly decreases post-ERCP pancreatitis (4,10,14,24-27). However, their effect is still controversial in the pediatric population. In contrast to the adults, a retrospective analysis by Troendle et al. showed that pancreatic stenting did not have the same effect in pediatric patients and could also be harmful (23). Compared to pancreatic stenting, the use of indomethacin as a non-invasive preventive method may be better justified.

Another rare and usually easily manageable complication is cholangitis. The identified risk factors are stenting of malignant strictures, combined percutaneous-endoscopic procedures, or failed biliary access for drainage. Incomplete stone extraction or unsuccessful or inappropriate stenting also predispose the patient to infection. Other related risk factors are the presence of jaundice, low case volume, and contamination from the duodenoscope. The use of pre- and postprocedural antibiotics can be helpful. However, if adequate biliary drainage is achieved, this may not be necessary (4,24).

Bleeding following ERCP is more common in patients undergoing ST. Although we have not experienced this complication in any of our pediatric patients, effective hemostasis is often endoscopically achieved. The use of 1:10,000 epinephrine is an adequate treatment in 96% of patients and recurrent bleeding is observed in only 5% (15,25). Plasma coagulation or hemostatic clips may also be useful (15,26,27). In adult patients, balloon tamponade works well in our practice.

The most dangerous complication is duodenal perforation. It can occur in the duodenal wall or at the periampullary region (4,14,25). Perforations in the duodenal wall usually result from the discrepancy between the size of the duodenoscope and duodenum. In such cases, surgery is the main therapeutic option (4,25). Periampullary and ductal perforations are consequences of ST and catheter or guide wire manipulation of the bile ducts (4,25). ST-related perforations are the most commonly encountered types (28). Biliary stent placement with adequate drainage is usually sufficient, but direct clipping (the last is typical for the cases with periampullary perforations) may also be useful (4,14,24,27).

It has been reported that the complication rate is lower if the procedure is carried out by specialists who perform



100 or more ERCPs per year than those who only perform 40 or less (12,29). Additionally, we believe that the use of deep sedation and close collaboration with anesthesiologists and pediatricians can yield better results. To the best of our knowledge, this study presents the longest period of follow-up in pediatric ERCP, which underlines the long-term safety of the procedure. We would also like to emphasize the efficacy of ERCP in managing postoperative complications as reoperations were successfully avoided in all of our patients. Children with a complicated hepatic hydatid disease should be particularly mentioned, because closure of the fistulas and full recovery was achieved with ST alone. The long-term follow-up in the pediatric population is mandatory, especially following therapeutic procedures. This is crucial not only to evaluate potential recurrent problems but also to keep an eye on the possibility of cholangiocarcinoma development reported in the literature for adults after surgical sphincteroplasty (30).

Limitations of the presented series are its retrospective nature, small study size, and the absence of a comparative group. But due to the rarity of these conditions in the pediatric population, coupled with lack of widespread expertise in pediatric ERCP, it may be difficult to conduct comparative studies. However, this series provides additional information to the pool of data on pediatric ERCP and may be useful in developing study hypotheses.

In conclusion, ERCP is a valuable tool in the diagnosis and treatment of pancreatobiliary disorders in the pediatric population. Success rates are high, and complications are low when performed by experienced endoscopists. Although there are controversial issues regarding indications, its place is undeniable. Large-scale studies are required to develop evidence-based guidelines specific to children.

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**Informed Consent:** Written informed consent was obtained from patients' parents who participated in this study.

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**Conflict of Interest:** The authors have no conflict of interest to declare.

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