



ERCP-Related adverse events in pediatric patients: a 10-years single-site review

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Abstract

Purpose This retrospective analysis aimed to assess the feasibility and safety of endoscopic retrograde cholangiopancreatography (ERCP) in pediatric patients by examining ERCP-related adverse events (AEs) occurring over a decade at a single center.

Methods Pediatric patients under 18 years old who underwent ERCP at the Second Hospital of Hebei Medical University from 1/2013 to 11/2023 were included. ERCP-related AEs were defined according to *ERCP-related adverse events: European Society of Gastrointestinal Endoscopy (ESGE) Guideline*. Clinical data of patients experiencing ERCP-related AEs were obtained from electronic medical records for analysis.

Results Over the past decade, a total of 76 pediatric patients underwent 113 ERCP procedures, including 26 patients who underwent repeat ERCP, totaling 63 procedures. There were 32 males and 44 females, with a median age of 13 years (range 3 years and 5 months–17 years and 9 months). Among all ERCP procedures, 14 (12.4%) were diagnostic and 99 (87.6%) were therapeutic, with a 100% success rate. 16 cases (14.2%) of ERCP-related AEs, all post-ERCP pancreatitis (PEP), were observed, while no other AEs defined by ESGE such as bleeding, perforation, cholangitis, cholecystitis, or sedation-related events were noted. Additionally, 23 cases (20.4%) of ERCP-related AEs not included in the ESGE definition were observed, including post-ERCP abdominal pain in 20 cases (17.7%), post-ERCP nausea and vomiting in 2 cases (1.8%), and unplanned reoperation in 1 case (0.9%). In the 26 cases of pediatric patients who underwent repeat ERCP, we observed that AEs occurred in 15 cases (57.7%) during their initial ERCP, which was much higher than the overall average level.

Conclusions Post-ERCP abdominal pain and PEP are the most common ERCP-related AEs in pediatric patients, while severe AEs such as bleeding and perforation are rare. The incidence of AEs after initial ERCP in pediatric patients who received repeat ERCP is higher than the overall average level. Based on our center's experience, we believe that ERCP can be safely performed in children over 3 years old with biliary and pancreatic diseases and obtain reliable clinical benefits. However, active monitoring and management of ERCP-related AEs are essential to improve the clinical outcomes of pediatric ERCP.

Keywords Pediatric patients · ERCP · Adverse events · Biliary · Pancreatic diseases

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Abbreviations

ERCP	Endoscopic retrograde cholangiopancreatography
AE	Adverse event
PEP	Post-endoscopic retrograde cholangiopancreatography pancreatitis
ESGE	European Society of Gastrointestinal Endoscopy
ESPGHAN	European Society for Paediatric Gastroenterology Hepatology and Nutrition
NSAID	Nonsteroidal anti-inflammatory drug
ERPD	Endoscopic retrograde pancreatic drainage
ENBD	Endoscopic nasobiliary drainage

Introduction

Endoscopic retrograde cholangiopancreatography (ERCP) is a common method for diagnosing and treating biliary and pancreatic diseases, playing a crucial role in diseases such as biliary obstruction, cholangitis, biliary and pancreatic strictures, pancreatitis and its complications, pancreatic tumors, and dysfunction of the Oddi sphincter [1]. ERCP has gained widespread application in adults; however, due to its technical complexity, it has the highest incidence of adverse events (AE) among all commonly used endoscopic procedures [2]. Therefore, enhancing clinicians' understanding of ERCP-related AEs is essential.

Pediatric patients present with physiological and anatomical differences compared to adults, which not only complicates the implementation of ERCP but may also lead to the occurrence of ERCP-related AEs distinct from those in adult patients. This imposes greater technical demands and risk management challenges on endoscopists. Currently, research on pediatric ERCP is relatively limited, particularly regarding reports of pediatric ERCP-related AEs. This study aims to summarize the incidence and characteristics of pediatric ERCP-related AEs, evaluate the feasibility and safety of performing ERCP in pediatric patients, and further optimize the diagnosis and treatment strategies for biliary and pancreatic diseases in children, providing safer and more effective clinical interventions for pediatric patients.

Methods

Definitions

Successful ERCP is defined as the successful cannulation of the bile duct or pancreatic duct, confirmation of the diagnosis by imaging, and completion of the corresponding treatment [3]. The definition and classification of ERCP-related AEs follow *ERCP-related adverse events: European Society of Gastrointestinal Endoscopy (ESGE) Guideline*, including post-ERCP pancreatitis (PEP), cholangitis, cholecystitis, bleeding, perforation, and sedation-related events [4]. They are defined as follows:

- PEP: new or worsened abdominal pain combined with > 3 times the normal value of amylase or lipase at more than 24 h after ERCP and requirement of admission or prolongation of a planned admission.
- Cholangitis: new onset temperature > 38 °C for more than 24 h combined with cholestasis.
- Cholecystitis: right upper quadrant signs of inflammation, systemic signs of inflammation, and imaging find-

ings characteristic of acute cholecystitis, without any suggestive clinical or imaging findings prior to ERCP.

- Bleeding: hematemesis and/or melena or hemoglobin drop > 2 g/dL.
- Perforation: evidence of gas or luminal contents outside of the gastrointestinal tract as determined by imaging.
- Sedation-related events: hypoxemia is defined hemoglobin oxygen saturation < 85%; hypotension or hypertension are defined either a blood pressure value < 90/50 or > 190/130 mmHg, or a change in value down or up 20%.

Additionally, several ERCP-related AEs not included in the ESGE definition were observed in this study, including post-ERCP abdominal pain, post-ERCP nausea and vomiting, and unplanned reoperation. They are defined as follows:

- Post-ERCP abdominal pain: new or worsened upper abdominal pain or discomfort after ERCP, without substantial organ damage such as PEP or cholangitis, and requiring additional medical measures.
- Post-ERCP nausea and vomiting: new or worsened nausea and/or vomiting after ERCP, requiring additional medical measures.
- Unplanned reoperation: a surgery performed for various reasons during the same hospitalization period.

Data Collection

After obtaining approval from the Ethics Committee of the Second Hospital of Hebei Medical University, medical records of 76 pediatric patients who underwent ERCP procedures at the hospital from 1/2013 to 11/2023 were collected for the study.

Inclusion criteria: (1) Age ≤ 18 years; (2) Clinical diagnosis of biliary and pancreatic diseases requiring hospitalization; (3) Indications for ERCP; (4) Signed informed consent for ERCP before the procedure.

Exclusion criteria: (1) Age > 18 years; (2) Refusal to undergo ERCP; (3) Incomplete clinical data.

All study data were obtained from the electronic medical record system of the Second Hospital of Hebei Medical University, including baseline information, clinical diagnosis, surgical plans, laboratory data, imaging data, and pathology.

ERCP Procedure

After admission, relevant examinations were conducted to confirm the indication for ERCP. Guardians of pediatric patients were informed of the associated procedural risks

and signed informed consent. Patients were required to fast for 8–12 h and abstain from drinking for 4 h before the procedure. During the procedure, patients were placed in the prone position and received either general anesthesia or general anesthesia with endotracheal intubation. Experienced endoscopists used duodenoscopes and related equipment to perform ERCP procedures.

Results

Basic information of patients

ERCP procedures were performed by four endoscopists from the Departments of Pediatric Surgery, Biliary and Pancreatic Endoscopic Surgery, Hepatobiliary Surgery, and Minimally Invasive Surgery. These endoscopists, all proficient in adult ERCP procedures, further obtained qualifications for performing ERCP in children, demonstrating extensive practice in pediatric ERCP treatment at our center.

A total of 76 pediatric patients were included in this study, comprising 32 males (42.1%) and 44 females (57.9%). The age ranged from 3 years and 5 months to 17 years and 9 months, with a median age of 13 years. Specifically, there were 8 cases (10.5%) aged 3–6 years, 15 cases (19.7%) aged 7–10 years, 20 cases (26.3%) aged 11–14 years, and 33 cases (43.4%) aged 15–18 years. All patients underwent ERCP for biliary and pancreatic diseases, including biliary obstruction in 40 cases (52.6%), chronic pancreatitis in 29 cases (38.1%), traumatic pancreatic duct rupture in 3 cases (4.0%), post-pancreatic tumor resection pseudocyst of the pancreas in 2 cases (2.7%), post-cholecystectomy bile leakage in 1 case (1.3%), and poorly differentiated adenocarcinoma of the duodenal papilla in 1 case (1.3%). A total of 113 ERCP procedures were performed in 76 pediatric patients, comprising 14 diagnostic ERCPS (12.4%) and 99 therapeutic ERCPS (87.6%), all of which were successfully conducted with a 100% success rate (Table 1).

26 pediatric patients underwent repeat ERCP, totaling 63 procedures. 17 pediatric patients (65.4%) underwent 2 ERCPS, 7 pediatric patients (26.9%) underwent 3 ERCPS, and 2 pediatric patients (7.7%) underwent 4 ERCPS. The distribution of diseases was as follows: chronic pancreatitis in 18 cases (69.2%), biliary obstruction in 4 cases (15.4%), post-pancreatic tumor resection pseudocyst of the pancreas in 2 cases (7.7%), traumatic pancreatic duct rupture in 1 case (3.8%), and post-cholecystectomy bile leakage in 1 case (3.8%) (Table 2).

ERCP-related AEs

Among the 113 ERCP procedures, a total of 39 (34.5%) ERCP-related AEs were observed, including post-ERCP

Table 1 Basic information of 76 pediatric patients undergoing 113 ERCPS

Item	Number of cases
Sex distribution	
Male	32 (42.1%)
Female	44 (57.9%)
Age distribution	
3–6 years	8 (10.5%)
7–10 years	15 (19.7%)
11–14 years	20 (26.3%)
15–18 years	33 (43.4%)
Disease distribution	
Biliary obstruction	40 (52.6%)
Chronic pancreatitis	29 (38.1%)
Traumatic pancreatic duct rupture	3 (4.0%)
Post-pancreatic tumor resection pseudocyst of the pancreas	2 (2.7%)
Post-cholecystectomy bile leakage	1 (1.3%)
Poorly differentiated adenocarcinoma of the duodenal papilla	1 (1.3%)
Operational attribute	
Diagnostic ERCP	14 (12.4%)
Therapeutic ERCP	99 (87.6%)

Table 2 The basic information of 26 pediatric patients undergoing repeat ERCPS

Item	Number of cases
Repeat ERCPS	
2 ERCPS	17 (65.4%)
3 ERCPS	7 (26.9%)
4 ERCPS	2 (7.7%)
Disease distribution	
Biliary obstruction	4 (15.4%)
Chronic pancreatitis	18 (69.2%)
Traumatic pancreatic duct rupture	1 (3.8%)
Post-pancreatic tumor resection pseudocyst of the pancreas	2 (7.7%)
Post-cholecystectomy bile leakage	1 (3.8%)

abdominal pain in 20 cases (17.7%), PEP in 16 cases (14.2%), post-ERCP nausea and vomiting in 2 cases (1.8%), and unplanned reoperation in 1 case (0.9%). No occurrences of bleeding, perforation, cholangitis, cholecystitis, or definite anesthesia-related risks were observed (Table 3).

We noted that among the 26 patients who underwent repeat ERCPS, 15 pediatric patients (57.7%) experienced ERCP-related AEs after the initial ERCP, including post-ERCP abdominal pain in 7 cases (26.9%), PEP in 6 cases (23.1%), post-ERCP nausea and vomiting in 1 case (3.8%), and unplanned reoperation in 1 case (3.8%) (Table 4).

Table 3 ERCP-related AE in 76 pediatric patients undergoing 113 ERCPs

Item	Number of cases
PEP	16 (14.2%)
Post-ERCP abdominal pain	20 (17.7%)
Post-ERCP nausea and vomiting	2 (1.8%)
Unplanned reoperation	1 (0.9%)
Total	39 (34.5%)

Table 4 Initial ERCP-related in 26 pediatric patients undergoing repeat ERCPs

Item	Number of cases
PEP	6 (23.1%)
Post-ERCP abdominal pain	7 (26.9%)
Post-ERCP nausea and vomiting	1 (3.8%)
Unplanned reoperation	1 (3.8%)
Total	15 (57.7%)

Discussion

With the continuous advancement of endoscopic technology, ERCP has become an important diagnostic and therapeutic tool for biliary and pancreatic diseases in adult surgery. In recent years, with the ongoing development of specialized instruments and equipment for pediatric use, ERCP has increasingly played a significant role in pediatric surgery as well. The 2017 guidelines from *Pediatric gastrointestinal endoscopy: European Society of Gastrointestinal Endoscopy (ESGE) and European Society for Paediatric Gastroenterology Hepatology and Nutrition (ESPGHAN) Guideline Executive summary* emphasized that biliary and pancreatic diseases are the main indications for pediatric ERCP [5]. At the same time, ERCP-related AEs cannot be ignored, and it is crucial to enhance awareness of these AEs. Herein, we summarize the occurrence of pediatric ERCP-related AEs at our center over the past decade.

Post-ERCP abdominal pain

Post-ERCP abdominal pain manifests as upper abdominal discomfort or pain occurring early after the ERCP procedure or an exacerbation of pre-existing symptoms. This abdominal pain often occurs earlier than PEP-related abdominal pain and can radiate to the lower back. In this study, we only included cases of abdominal pain that required medical intervention, totaling 20

cases, accounting for 17.7% of the total ERCP procedures and representing the most common ERCP-related AE. A retrospective study conducted on all patients who underwent ERCP treatment at a single center found that age ≤ 65 years, primary ERCP, dilated extrahepatic bile duct, no papilla opening, pancreatic guidewire passages, lower WBC, lower PLT, normal γ -GT and elevated albumin were independent risk factors for post-ERCP abdominal pain without PEP. According to the literature, the incidence of post-ERCP abdominal pain without PEP is reported to be 7.72%, including 14 post-ERCP cholangitis, 2 post-ERCP hemorrhage and 84 nonspecific abdominal pain [6]. However, in our study, the incidence of post-ERCP abdominal pain was 17.7%, higher than that reported in the literature. We believe that the higher incidence of post-ERCP abdominal pain in children compared to adults can be attributed to the following reasons: Firstly, prolonged absorption of air during endoscopic examinations may cause pain and abdominal distension [7]. Due to the immature physiological structure of children, the difficulty of ERCP surgery is higher than that of adults, primarily due to the narrow and fragile structures of pancreatic ducts, bile ducts, and intestinal tracts. More delicate and cautious manipulation is required, which often results in longer operation time to ensure the safety and effectiveness of the surgery. We also consider that the intestinal wall of children is thinner than that of adults, leading to more severe dilation of the intestinal tract under the same gas pressure during procedure, which results in stronger abdominal discomfort. This accounts for the main reason in the cases we observed. Secondly, bile duct spasms and intestinal spasms are also common causes of abdominal pain after ERCP. Children have narrower pancreatic and biliary ducts with thinner duct walls. Despite the use of specialized equipment for pediatric ERCP, it is still easier to stimulate the biliary muscles and trigger biliary spasms. The duodenal papilla opening is narrower in children compared to adults, and post-ERCP papillary edema can further exacerbate the narrowing, making it easier to cause obstruction of the biliary or pancreatic ducts, leading to abdominal pain. Furthermore, nasal biliary duct and stent placement may cause pain in the upper right abdomen of patients. Double pigtail ducts tend to induce liver pain more than linear ones. Additionally, for patients with gallbladder stones and choledocholithiasis, due to changes in biliary tract pressure, cholecystitis-induced abdominal pain may occur after ERCP, but this is not a common occurrence [8]. Lastly, a study on pediatric pain suggests that children may be more sensitive to pain, not only due to physiological differences but also psychological and emotional factors [9]. Therefore, even with the same degree of physiological stimulation, children may exhibit a stronger pain response.

Although post-ERCP abdominal pain is usually not severe, it can impact the comfort and treatment satisfaction of pediatric patients. A study found that intravenous administration of ibuprofen at 10 mg/kg significantly decreased post-ERCP pain scores and the incidence of post-ERCP abdominal pain in children, suggesting that ibuprofen may be a feasible method for managing post-ERCP pain [10]. To alleviate these symptoms, we have taken measures such as fasting, gastrointestinal decompression, adjustment or removal of nasal biliary duct and stents, administration of antispasmodic drugs and non-steroidal anti-inflammatory drugs (NSAID). These strategies aim to reduce the incidence of post-ERCP abdominal pain and improve patient comfort and satisfaction. In our clinical practice, we have found that most cases of abdominal pain after pediatric ERCP can be relieved within 48–96 h after adopting the aforementioned measures.

PEP

PEP manifests as upper abdominal pain or exacerbation of pre-existing pain after ERCP, accompanied by elevated serum amylase or lipase levels. In our study, we observed 16 cases of PEP, accounting for 14.2% of all ERCP procedures. ERCP procedures for pancreatic diseases involve maneuvers such as pancreatic duct cannulation and placement of pancreatic stents, which increase the risk of PEP due to mechanical, pressure-related, and chemical factors [11]. ESGE has identified patient-related risk factors for PEP as suspected sphincter of Oddi dysfunction, female sex, previous pancreatitis, previous PEP, while Procedure-related risk factors include difficult cannulation, pancreatic guidewire passages > 1, and pancreatic injection [4]. A study on children and young adults identified factors associated with the development of PEP, including procedural factors such as pancreatic duct injection, cannulation, and sphincterotomy, anatomic factors such as pancreas divisum, complexity scoring, and patient related factors such as a prior history of PEP [12]. The incidence of PEP in the general population is reported to be 3 to 10% [2], while in our study, the incidence was 14.2%, higher than reported in the literature. We attribute this higher incidence in children to narrower pancreatic ducts and smaller papillary openings compared to adults, making cannulation and pancreatic stent insertion more challenging. Additionally, some children may have congenital anatomical factors such as pancreatic division, contributing to the higher incidence of PEP in children compared to adults.

The importance of PEP prevention and management has garnered increasing attention. Preoperative use of NSAIDs has been proven effective in adult patients undergoing ERCP [10]. A multi-center study from the United States and Canada reported that in high-risk PEP patients over 18 years of

age, a strategy of indomethacin alone was not as effective as a strategy of indomethacin plus prophylactic pancreatic stent placement. These results support prophylactic pancreatic stent placement in addition to rectal indomethacin administration in high-risk patients, in accordance with clinical practice guidelines. [13]. A study found that pancreatic stent placement decreases the risk of post-ERCP pancreatitis and hyperamylasemia in high-risk patients, but its therapeutic effect on severe PEP was not significant [14]. In 2017, ESGE and ESPGHAN strongly recommend administering NSAIDs (diclofenac/indomethacin suppository) through the anus to prevent the occurrence of PEP in children older than 14 years [5]. Currently, there is still a lack of research on the effectiveness of preoperative drug use in preventing PEP in children under 14 years old. After the occurrence of PEP, clinical treatment typically involves ascertaining the risk factors for pancreatitis and removing or targeting their treatment, minimizing inflammatory damage (particularly multiorgan dysfunction), assessing and managing complications of pancreatitis, controlling pain symptoms [15]. For the patients in our study, following these principles of treatment resulted in effective control and alleviation of PEP-related abdominal pain, with normalization of serum amylase and lipase levels.

Post-ERCP nausea and vomiting

In our study, we observed two cases of severe nausea and vomiting after ERCP, accounting for 1.8% of all ERCP procedures. One patient was diagnosed with biliary stones with infection and underwent ERCP stone removal, endoscopic retrograde pancreatic drainage (ERPD), and endoscopic nasobiliary drainage (ENBD) procedures. The other patient was diagnosed with biliary stones with infection and acute pancreatitis, and underwent ERCP stone removal and ENBD procedures. Both patients experienced severe nausea and vomiting postoperatively, which persisted for 72–96 h despite symptomatic treatment with antiemetics.

Nasobiliary tube is a tube to drain bile from the biliary system externally, primarily aimed at establishing drainage, relieving obstruction, reducing bile duct pressure, and preventing infection. A study found that leaving a nasobiliary in place tube may cause nasal-pharyngeal irritation leading to nausea and vomiting. Additionally, bile drainage via the nasobiliary tube may interfere with the normal flow and distribution of bile in the intestines, affecting gastrointestinal function and causing nausea and vomiting [16]. Furthermore, anesthetic agents used during surgery can also cause nausea and vomiting, with some patients being more sensitive to specific anesthetic drugs [17].

A study focusing on patients with common bile duct stones complicated by acute cholangitis indicated the importance of a strict assessment of the necessity of nasobiliary

tube placement preoperatively. The study found that leaving the nasobiliary tube in place did not provide additional clinical benefits to patients but instead prolonged operation time and increased patient discomfort [18]. Another study showed that using an improved “tube-nose-ear” three-step fixation technique significantly reduce nausea and vomiting after ENBD, facilitate biliary drainage, and improve patient comfort [19]. For postoperative nausea and vomiting due to anesthetic drugs, Kovac emphasized the importance of multimodal pain management (including preoperative regional anesthesia and reducing the use of opioid drugs) and prophylaxis with combination drug therapy (such as dexamethasone and 5-HT₃ receptor antagonists). Additionally, non-pharmacological treatment methods such as preoperative carbohydrate intake and adequate fluid supplementation were suggested [17].

Unplanned reoperation

In this study, we observed 1 case of unplanned reoperation after ERCP, accounting for 0.9% of the total ERCP operations. The case involved a 8-year-old female patient with chronic pancreatitis and pancreatic duct stones who was admitted to the hospital due to intermittent abdominal pain and vomiting for 3 years. Laboratory tests showed a slight increase in blood amylase levels and normal urine amylase levels. ERCP imaging revealed stenosis of the pancreatic head, dilation of the distal pancreatic duct, and multiple stones in the pancreatic duct, with the largest stone measuring approximately 1.0 cm*0.6 cm. A stone retrieval basket was used to remove the stones from the pancreatic duct, and two pancreatic stents of 5Fr and 7Fr were placed in the pancreatic duct. After the operation, the patient's abdominal pain subsided and her blood amylase levels returned to normal. However, as her diet gradually increased, the abdominal pain worsened again. Repeated tests showed normal blood amylase and urine amylase levels, and pancreatic ultrasound did not reveal dilation of the pancreatic duct. Despite aggressive symptomatic treatment, the patient's abdominal pain persisted, and she underwent the second ERCP examination seven days after the initial ERCP. During the second procedure, it was observed that the pancreatic stents had partially dislodged from the pancreatic duct and were located at the duodenal papilla. The stents were subsequently removed using a snare. Following the removal of the stents, the patient's abdominal pain rapidly subsided. Cases of secondary ERCP for removal of pancreatic stents due to intolerance after pediatric ERCP are rare and have not been reported previously. A meta-analysis of adverse events related to pancreatic stent placement in adults has shown that stent placement may lead to stent occlusion, stent migration, cholangitis and cholecystitis, infection, pseudocysts, bleeding,

retroperitoneal perforation, pancreatic duct perforation, and pancreatic necrosis [20]. In this case, the patient experienced more severe abdominal pain after pancreatic stent placement during the initial ERCP compared to before the operation, despite normal blood amylase and urine amylase levels and no dilation of the pancreatic duct on pancreatic ultrasound. The abdominal pain was rapidly relieved after the removal of the pancreatic stents, suggesting that the patient's abdominal pain was caused by pancreatic duct spasms stimulated by stent migration. This case suggests that for patients undergoing pancreatic stent placement after ERCP, if they develop intolerable abdominal pain that does not respond to symptomatic treatment, active implementation of a second ERCP should be considered to identify the cause and provide the correct solution.

Repeat ERCP

In this study, we observed that 26 of the 76 children who underwent ERCP received repeat ERCP. A total of 39 ERCP-related AEs occurred in the 113 ERCP procedures (34.5%), while 15 ERCP-related AEs occurred in the 26 children who received repeat ERCP after their initial ERCP (57.7%). These data indicate that children who receive repeat ERCP have a significantly higher rate of AEs during their initial ERCP compared to the overall average level, suggesting that AEs are more likely to occur during the initial ERCP in children who receive repeat ERCP. This finding is consistent with the conclusions of a multi-center study on factors related to complications of pediatric ERCP [21].

Disease distribution of pediatric ERCP

In this study, we further observed the distribution of pediatric ERCP across different diseases. Among the 76 children who underwent ERCP, the top three diseases were biliary obstruction (52.6%), chronic pancreatitis (38.1%), and traumatic pancreatic duct rupture (4.0%). Among the 26 children who received repeat ERCP, the top three diseases were chronic pancreatitis (69.2%), biliary obstruction (15.4%), and post-pancreatic tumor resection pseudocyst of the pancreas (7.7%). These data indicate that biliary obstruction is the main indication for pediatric ERCP, while chronic pancreatitis is the primary disease indication for repeat ERCP. A study suggested that pancreatic diseases such as recurrent pancreatitis, chronic pancreatitis, and pancreatic divisum are closely associated with repeat ERCP > 5 times [21]. Another study has shown that there are differences in the indications for ERCP across different age groups of pediatric patients. The main role of ERCP was in excluding biliary atresia in those aged less than 1 year, and it has good

application value in avoiding unnecessary Kasai surgeries for infants suspected of having biliary atresia. In children aged 1 to 6 years, the most frequent diagnoses were choledochalyst followed by choledocholithiasis. In children aged 7 to 12 years and 13 to 19 years, the most frequent diagnoses were choledocholithiasis followed by pancreatic pathology [22]. These viewpoints are consistent with our research findings.

Limitations

Although our study summarizes and analyzes the occurrence and characteristics of ERCP-related AEs in children, and initially assesses the feasibility and safety of pediatric ERCP implementation, there are still certain limitations. As a single-center study, our conclusions may be limited by the specific patient population and operational techniques of this center. Additionally, as a retrospective study, there may be biases in data collection. Future research should focus on prospective, large-sample, multi-center studies to obtain more comprehensive data and more reliable evidence.

Conclusions

ERCP, as an important diagnostic and therapeutic tool for biliary and pancreatic diseases in children, has gradually been carried out in more and more medical centers. The physiological structure and functional characteristics of children differ from adults, making the implementation of pediatric ERCP surgeries more challenging. This also leads to differences in the occurrence and characteristics of ERCP-related AEs in children compared to adults. Therefore, it is crucial to enhance the understanding of pediatric ERCP-related AEs. Our research indicates that post-ERCP abdominal pain and PEP are the most common ERCP-related AEs, while severe AEs such as bleeding and perforation are rare. In children who received repeat ERCP, the incidence of AEs related to their initial ERCP is higher than the overall average level. Based on our center's experience, we believe that ERCP can be safely performed in children over 3 years old with biliary and pancreatic diseases, achieving reliable clinical benefits. However, it is essential to continuously strengthen the professional training of pediatric endoscopists, proficiently master the skills of pediatric ERCP, and actively monitor and manage pediatric ERCP-related AEs. This will help improve the clinical outcomes of pediatric ERCP.

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Data availability The dataset generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

Declarations

Conflict of interest The authors declare no competing interests.

Ethical approval This study has obtained approval from the Ethics Committee of the Second Hospital of Hebei Medical University.

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