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**Efficiency of upper gastrointestinal endoscopy in pediatric surgical practice**

Temiz A. Upper gastrointestinal endoscopy in pediatric surgery

**Abdulkerim Temiz**

**Abdulkerim Temiz,** Department of Pediatric surgery, Başkent University, Faculty of Medicine, Adana Research and Educational Hospital, 01150 Seyhan, Turkey

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**Correspondence to: Dr. Abdulkerim Temiz, MD, Associate Professor,** Department of Pediatric Surgery, Baskent University, Faculty of Medicine, Adana Research and Educational Hospital, Baraj Road, 1. Stop, Seyhan Hospital, 01150 Seyhan, Turkey.aktemiz@yahoo.com

**Telephone:** +90-322-4586868-1000

**Fax:** +90-322-4592622

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**Abstract**

After the introduction of flexible fiber optic endoscopy to pediatric gastroenterology in the 1970s, upper gastrointestinal (UGI) endoscopy can be performed for diagnosis and treatment of all age groups of children. We review indications, contraindications, preparation of patients for the procedure, and details of diagnostic and therapeutic UGI endoscopy used in pediatric surgery. We also discuss potential complications of endoscopy.

**Key words:** Endoscopy; Upper gastrointestinal system; Pediatric surgery; Diagnosis; Treatment

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**Core tip:** Flexible upper gastrointestinal (UGI) endoscopy is a diagnostic and therapeutic procedure accepted world-wide for some upper gastrointestinal diseases in children. With the advances and innovations in the field of pediatric endoscopy and equipment, UGI endoscopic procedures have been safely and effectively used in children with minor complications in experienced hands. In this review, we summarize the efficiency of UGI endoscopic procedures in pediatric surgery.

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**INTRODUCTION**

The anatomical area located above the junction of the duodenum and jejunum is described as the upper gastrointestinal (UGI) system. It includes the mouth, pharynx, esophagus, stomach and duodenum with the extra hepatic pancreaticobiliary tree. Many congenital or acquired pathologies of the UGI system are encountered in pediatric surgical practice. Several diagnostic and therapeutic endoscopic interventions are required in some of these patients. After the introduction of flexible fiber optic endoscopy to pediatric gastroenterology in the 1970s, and through technological developments in the size and flexibility of endoscopes, upper gastrointestinal endoscopy can be performed even on premature infants from the first day of birth by smaller endoscopes[1-5]. Initially, endoscopy was used only for diagnostic study in children. With advances and innovations in the field of pediatric endoscopy and equipment, the frequency of therapeutic procedures such as removal of ingested foreign bodies, percutaneous endoscopic gastrostomy (PEG), ligation of esophageal varices, polypectomy, injection therapy, endoscopic retrograde cholangiopancreaticography (ERCP), and peroral endoscopic myotomy (POEM) has gradually increased in children.

**DIAGNOSTIC ENDOSCOPY**

Dyspepsia, upper gastrointestinal bleeding and abdominal pain are the most common indications for diagnostic UGI endoscopy in pediatric surgical practice[3,4,6-10]. The indications are summarized in Table 1[1-3]. Because endoscopy is performed easily and quickly, the numbers of negative endoscopy increase gradually and cause increased economic burden. However as a result of this practice several new diseases and pathologies of the UGI system in childhood have been described[10]. There is still no definitive description of dyspepsia. Epigastric pain, fullness, vomiting, regurgitation, nausea, abdominal discomfort, and bloating are commonly accepted as dyspeptic symptoms[11]. Gauriso *et al*[11] reported that endoscopy is not necessary for all children with dyspeptic symptoms. They recommended endoscopy for patients with a family history of peptic ulcer or *Helicobacter pylori* infection, older than 10 years of age, with symptoms continuing for more than 6 months or whose daily activities are affected. Various disorders such as gastritis, duodenitis, esophagitis, and peptic ulcer may cause recurrent or chronic abdominal pain in children. UGI endoscopy should be performed in children with intractable or unexplained abdominal pain. Multiple biopsies should be done randomly from esophagus, stomach and duodenum during endoscopy especially from distal esophagus and antrum, even if these areas are macroscopically normal.

UGI bleeding is not uncommon and is usually a self-limited clinical condition. The causes of UGI bleeding are listed in Table 2[3,12-15]. UGI bleeding affected only 5% of patients who underwent UGI endoscopy[12]. Although causes vary among reports, excessive UGI bleeding commonly arises from esophageal varices, peptic ulcer, gastritis, esophagitis or esophageal ulcer[3,13-15]. Polyps, inflammatory disorders, Dieulafoy’s lesion or vascular malformations such as angioectasia are less common in children[3,16-19]. The causes and sources of UGI bleeding are defined by endoscopy in 85%-90% of patients. Rates of misdiagnosis of bleeding of between 10% and 27% have been reported in different studies[15,20,21].

The diagnosis of gastroesophageal reflux disease (GERD) is commonly made by pH meter, barium meal test or scintigraphy. Endoscopy and esophageal biopsy are used for the diagnosis of complicated GERD, suspected but unproven or demonstrated GERD, or to exclude other diseases that can mimic GERD such as eosinophilic or infectious esophagitis and Crohn’s disease[22,23]. Because normal endoscopic appearance of esophageal mucosa does not exclude esophagitis, endoscopic biopsy should be done in all patients. The tonus of the lower esophageal sphincter and the location of the esophagogastric junction are also considered. El Mouzan *et al*[23] reported that esophageal pH monitoring was the most specific diagnostic study (91% specificity), whereas endoscopy was the most sensitive diagnostic tool (92% sensitivity) for GERD.

Caustic ingestion is another common clinical condition which requires UGI endoscopy in pediatric surgical practice. Different diagnostic trials such as radiocontrast esophagography, scintigraphy, and esophageal ultrasound have been conducted to diagnose caustic injuries. Several studies have reported that clinical signs are not always helpful in predicting the degree of injury[24-26]. Upper GIS endoscopy is the most effective method for establishing the severity of injury and for planning treatment. Because the esophagus is weakest between days 7 and 21 after caustic injury and the frequency of endoscopic complications also usually increases during this period, endoscopy is recommended in the first 24-48 h of injury[24-26]. It is usually recommended to stop endoscopy at the first circumferential esophageal burn because of the increased risk of complications beyond this point[27]. This approach might cause a more severely burned esophagus or stomach to be missed. We observed severe gastric injury in 18.4% patients; gastric injury was more severe than esophageal injury in 3.4% of patients in our study[28]. Therefore we suggest complete upper GİS endoscopy if possible in children with caustic injuries[28]. Upper gastrointestinal endoscopy revealed severe esophageal injury in 19.3% of our patients that did not have symptoms. In contrast, 59.7% of the patients with positive clinical symptoms had no or grade 1 esophageal injury. In these circumstances endoscopy prevents unnecessary hospitalization and also decreases complication rates[28].

**DIAGNOSTIC ENDOSCOPY WITH THERAPEUTIC PROCEDURES**

Massive UGI bleeding is a life-threatening condition and requires expeditious resuscitation and hemostatic therapy. Massive bleeding usually results from peptic ulcer, esophageal varices, Dieulafoy’s lesion or vascular malformations[3,14,20]. Therapeutic interventions should be attempted at the same time as diagnostic endoscopy in the presence of active bleeding, non-bleeding visible vessels, or adherent cloth. Endoscopic therapies include adrenalin or alcohol injection, thermal coagulation, band ligation, tissue adhesives and mechanical clamping[3,4]. Similarly, diagnosis of polyposis and polypectomy can be made as successive procedures[3,6].

Endoscopic retrograde cholangiopancreatography (ERCP) has been widely accepted as both a diagnostic and a therapeutic tool for extrahepatic biliary and pancreatic diseases. The most common indication for ERCP, especially for its use as a treatment procedure in children, is biliary obstruction[29,30]. Complication rates of ERCP have been reported as between 3.4% and 28.5%. The most common complications associated with ERCP are pancreatitis, hemorrhage, infection and perforation[30,31]. In joint diagnostic and therapeutic procedures such as ERCP, interventions to stop bleeding are usually performed by pediatric gastroenterologists. These procedures are not common in pediatric surgical practice.

**THERAPEUTIC UPPER GASTROINTESTINAL ENDOSCOPY**

***Foreign body ingestion***

Foreign body ingestions are usually encountered in small children under 5 years of age or older children. The elder children are usually with mental retardation. Most (98%) are reported as accidental events[32,33]. Coins are the most commonly ingested foreign body, in approximately 70% of children[34]. However, toys, jewelry, magnets, and batteries are other commonly ingested foreign bodies[32]. Patients are asymptomatic 50% of the time; drooling, pain, refusal to feed, dysphagia, stridor, wheezing, and respiratory distress are the most common symptoms in the remaining 50% of patients[32,35,36]. Plain radiography is still the most used diagnostic. Barium meal study or computed tomography are indicated especially in cases of ingestion of a non-contrast object or for patients with complications[33,37]. The location of impaction usually relates to the age of the child and the size and shape of the foreign body. The esophagus, especially the upper esophageal sphincter, is the most common anatomical site for impaction of foreign bodies. The second and third most frequent anatomical sites of impaction are at the level of T4 where the distal aortic arch descends posterior to the esophagus, and the lower esophageal sphincter, respectively. Although 80%-90% of foreign bodies pass through the gastrointestinal system spontaneously, 10% or 20% of the remaining cases require endoscopic extraction. Only 1% of patients need surgery[37]. Foreign bodies detected in the stomach and intestines often tend to pass spontaneously[34]. The complication rates increase with pointed and sharp foreign bodies, button batteries, and magnets. Esophageal perforation has been detected in 2%-15% in different studies of patients with an esophageal foreign body[34]. Serious complications such as mucosal erosion, ulcer, esophageal or intestinal perforation, pneumothorax, pneumomediastinum, tracheoesophageal fistula and cervical abscess may be developed secondary to foreign body ingestion[36]. Removal of foreign bodies which are located in the esophagus is mandatory to prevent complications.

Button batteries, in particular, may lead to perforation secondary to the caustic injury or pressure effect. As a result, esophageal button batteries should be removed immediately. Ingestion of multiple magnets is another special condition, because if multiple magnets ingests at different times they may clinging and cause intestinal perforation, peritonitis or enteroenteric fistula. For this reason, magnets should be removed as soon as they are identified[32].

The removal of the foreign bodies by endoscopy must be performed under general anesthesia with intubation to provide respiratory security. The method differs according to the shape and location of the foreign body. Use of McGill forceps is an easy procedure for foreign bodies located above the cricopharyngeal sphincter. Below this anatomical level, rigid or flexible endoscopy is required to remove foreign body impactions.

***Percutaneous endoscopic gastrostomy***

Several gastrostomy or enterostomy techniques have been described to establish long-term enteral feeding in children and adults. Stamm gastrostomy was the first surgical technique introduced for enteral nutrition. Laparoscopic gastrostomy is another method for insertion of a gastrostomy tube. Because it is less invasive and more cost effective than surgical procedures, PEG has increasingly been used since it was described by Gauderer *et al*[38,39]. PEG is the most preferred technique especially for patients with neurological diseases[38]. However Baker *et al*[40] revealed that there is increased risk of major complications of PEG compared to the laparoscopic gastrostomy[40]. The rate of complications can be reduced by an experienced endoscopist. Indications of PEG are summarized in Table 3[38,39].

**Operative technique:** The most preferred technique is the “pull” technique described by Gauderer[39,41]. Flexible endoscopy is performed using an appropriately sized endoscope. The stomach is insufflated. The optimal location for placement of the PEG is confirmed with both transillumination and finger indentation. A small incision less than 0.5 cm is made, then the stomach is cannulated with a needle or cannula. A thread is passed into the stomach through the cannula, grasped with a snare and pulled out of the mouth with a flexible endoscope. The PEG tube is connected to the thread and pulled from the mouth antegrade into the stomach. The bumper of the PEG tube is lubricated and manipulated to prevent esophageal damage. Finally, the position of the flange is confirmed by control endoscopy[38,39].

**Replacement of PEG tube:** Replacement of old, damaged or plugged PEG tubes is also performed by endoscopy. The bumper of the PEG catheter is removed endoscopically. A thread is passed into the stomach through the existing gastrostomy tunnel. Subsequent steps are identical to the initial insertion of the PEG tube.

***Esophageal and pyloric dilation***

UGI strictures are usually located at the esophageal level in children. Pyloric obstruction is encountered in fewer patients. The most common cause of benign esophageal stricture is ingestion of a caustic substance[42,43]. Esophageal strictures in children may be caused by congenital anomaly, foreign body ingestion, or be secondary to gastroesophageal reflux or esophageal surgery. However, of several possible surgical procedures, dilation with bougienage or balloon is the first choice of treatment for benign esophageal stricture in children[44,45]. Endoscopic or fluoroscopically guided bougienage or balloon dilation is recommended as a safe and effective treatment in children with benign esophageal stricture to reduce complication rates[44].

Pyloric stricture (PS) may be caused by peptic ulcer, granulomatous diseases and eosinophilic gastroenteritis, and caustic injury or unknown causes in children[46-48]. Diagnosis of PS is based on barium swallow. Endoscopic examination and biopsy of the upper gastrointestinal system should be performed to investigate the etiology of PS. Surgical correction is still the most common treatment in the majority of cases of PS[42]. However, there are some studies on endoscopic balloon dilation performed in children with PS. In these reports, success rates for balloon dilation have been reported between 16 and 80% with benign PS[49,50].

**Technique:** Endoscopy is performed under general anesthesia with tracheal intubation. After focusing on the narrowed esophagus or pylorus, a radiopaque guide wire is inserted under endoscopic guidance. A balloon catheter is passed over the guide wire and placed through the narrowed esophagus and pylorus. The location of the balloon is monitored endoscopically in pyloric dilation. Then the balloon is inflated with radiocontrast solution under fluoroscopy to the recommended level of pressure marked on each catheter. Inflation is performed for two minutes after expansion of the hourglass deformity of the stricture[42].

The balloon size is increased to the appropriate diameter as determined by the thumb rule for esophageal stricture. For PS, the preferred diameter of the balloon is 12-14 mm for infants and 15-18 mm for older children[42].

***Miscellaneous procedures***

In addition to the widespread use of endoscopy in diagnostic and therapeutic procedures, several reports presented as case reports or with limited patients include new therapeutic approaches for UGI diseases that are gradually increasing in popularity. Endoscopic treatments of duodenal duplication and duodenal web have recently been reported[51,52]. Peroral endoscopic myotomy (POEM) has been described for achalasia in adults; clinical results of its use in children have been presented with small numbers of patients[53,54].

**CONTRAINDICATIONS**

Although endoscopy can be performed on children of any age from the first day of life to adolescents, it is contraindicated in patients with unstable airways, cardiovascular collapse, intestinal perforation or peritonitis[5]. Intestinal obstruction, neutropenia, severe thrombocytopenia, coagulopathy, recent gastrointestinal surgery, unstable cardiopulmonary diseases, and recent oral intake are accepted as relative contraindications[4,5].

**ANTIBIOTIC PROPHYLAXIS**

Antibiotic prophylaxis is not recommended for diagnostic endoscopy except for specific conditions, including congenital cardiac anomalies, cardiac surgery, neutropenia or ventriculoperitoneal shunt. However prophylactic antibiotic administration is suggested before diagnostic endoscopy with those clinical conditions and for all therapeutic endoscopic interventions such as insertion of PEG, endoscopic dilation, sclerotherapy, band ligation, and ERCP[5]. Ampicillin with sulbactam is the most commonly used antibiotic for this aim.

**ANESTHESIA**

Sedation with analgesia or general anesthesia is the accepted approach for endoscopy as for other interventional procedures in children. Sedation and general anesthesia facilitate endoscopic procedures and decrease the emotional stresses from separation from parents, analgesia and amnesia[4-9]. Detailed examination is recommended to choose an appropriate anesthetic modality and to reduce complications. The preferred anesthetic method and drugs should be decided by the endoscopist and anesthesiologist together[4,8]. Moderate sedation is the most preferred sedation regimen for endoscopy in children. Infants under seven months old are at higher risk because of obligatory nasal breathing; however, it has been reported that endoscopy is safe and uncomplicated with a trained practitioner even in neonates[1]. Under moderate sedation protective airway reflexes and spontaneous breathing remain active during endoscopy[5,9]. Midazolam, fentanyl, propofol and ketamine are the most commonly used anesthetic agents during endoscopy. The cardiovascular and respiratory systems of all patients should be monitored by electrocardiography and oxygen saturation. Endoscopy, especially in therapeutic interventions, should be performed under general anesthesia with endotracheal intubation in patients with poor general condition, severe respiratory disease or complex planned procedures.

**COMPLICATIONS**

UGI endoscopy and co-procedures are generally accepted as safe interventions in experienced hands. The complication rates reported are usually less than 2%-3% and decrease with age[55,56]. There are several complications associated with endoscopy or related procedures in the literature. Most are minor[55]. Complications are considered in two main groups. The first group is associated with anesthesia, such as delayed extubation, bronchospasm, and fever. Lee *et al*[13] reported minor complications in 1.5% of patients. The second group are complications associated with endoscopy and related procedures.

***Complications after diagnostic endoscopy and endoscopic biopsy***

UGI hemorrhage and duodenal hematoma may occur secondary to the endoscopy[13,57-59]. Lee *et al*[13] observed secondary bleeding following rubber banding or sclerotherapy in 3.4% of patients. Iqbal *et al*[60] reported bleeding, perforation and mucosal tears as iatrogenic complications in six of 9308 upper gastrointestinal endoscopy procedures (0.06%). A conservative approach is usually sufficient for improvement in patients without peritonitis[60].

***Complications of PEG***

Complications due to PEG insertion or tube are divided into major and minor complications, summarized in Table 4[38,39,61-65]. Hepatic injury secondary to the PEG placement was reported in one adult. Peristomal wound infection accounts for 30% of complications[64,66]. The risk of wound infection increases in patients with obesity, diabetes mellitus or malnutrition. Prophylactic antibiotic administration significantly reduces the risk of peristomal wound infection[64,66].

**CONCLUSION**

With an experienced practitioner, endoscopy is a safe and effective diagnostic and therapeutic procedure even for premature infants. Complications can easily be prevented.

**REFERENCES**

1 **Dupont C**, Kalach N, de Boissieu D, Barbet JP, Benhamou PH. Digestive endoscopy in neonates. *J Pediatr Gastroenterol Nutr* 2005; **40**: 406-420 [PMID: 15795585]

2 **Volonaki E**, Sebire NJ, Borrelli O, Lindley KJ, Elawad M, Thapar N, Shah N. Gastrointestinal endoscopy and mucosal biopsy in the first year of life: indications and outcome. *J Pediatr Gastroenterol Nutr* 2012; **55**: 62-65 [PMID: 22210413 DOI: 10.1097/MPG.0b013e3182478f83]

3 **Rahman I**, Patel P, Boger P, Rasheed S, Thomson M, Afzal NA. Therapeutic upper gastrointestinal tract endoscopy in Paediatric Gastroenterology. *World J Gastrointest Endosc* 2015; **7**: 169-182 [PMID: 25789087 DOI: 10.4253/wjge.v7.i3.169]

4 **Lightdale JR**, Acosta R, Shergill AK, Chandrasekhara V, Chathadi K, Early D, Evans JA, Fanelli RD, Fisher DA, Fonkalsrud L, Hwang JH, Kashab M, Muthusamy VR, Pasha S, Saltzman JR, Cash BD. Modifications in endoscopic practice for pediatric patients. *Gastrointest Endosc* 2014; **79**: 699-710 [PMID: 24593951 DOI: 10.1016/j.gie.2013.08.014]

5 **Friedt M**, Welsch S. An update on pediatric endoscopy. *Eur J Med Res* 2013; **18**: 24 [PMID: 23885793 DOI: 10.1186/2047-783X-18-24]

6 **Lee KK**, Anderson MA, Baron TH, Banerjee S, Cash BD, Dominitz JA, Gan SI, Harrison ME, Ikenberry SO, Jagannath SB, Lichtenstein D, Shen B, Fanelli RD, Van Guilder T. Modifications in endoscopic practice for pediatric patients. *Gastrointest Endosc* 2008; **67**: 1-9 [PMID: 18155419]

7 **Chen PH**, Wu TC, Chiu CY. Pediatric gastrointestinal endoscopic sedation: a 2010 nationwide survey in Taiwan. *Pediatr Neonatol* 2012; **53**: 188-192 [PMID: 22770108 DOI: 10.1016/j.pedneo.2012.04.006]

8 **Bartkowska-Śniatkowska A**, Rosada-Kurasińska J, Zielińska M, Grześkowiak M, Bienert A, Jenkins IA, Ignyś I. Procedural sedation and analgesia for gastrointestinal endoscopy in infants and children: how, with what, and by whom? *Anaesthesiol Intensive Ther* 2014; **46**: 109-115 [PMID: 24858971 DOI: 10.5603/AIT.2014.0021]

9 **Dar AQ**, Shah ZA. Anesthesia and sedation in pediatric gastrointestinal endoscopic procedures: A review. *World J Gastrointest Endosc* 2010; **2**: 257-262 [PMID: 21160616 DOI: 10.4253/wjge.v2.i7.257]

10 **Alabd Alrazzak B**, Husien T, Preston DL, Elitsur Y. Upper endoscopy in children: do symptoms predict positive findings? *Clin Pediatr* (Phila) 2014; **53**: 474-478 [PMID: 24707023 DOI: 10.1177/0009922814528034]

11 **Guariso G**, Meneghel A, Dalla Pozza LV, Romano C, Dall'Oglio L, Lombardi G, Conte S, Calacoci M, Campanozzi A, Nichetti C, Piovan S, Zancan L, Facchin P. Indications to upper gastrointestinal endoscopy in children with dyspepsia. *J Pediatr Gastroenterol Nutr* 2010; **50**: 493-499 [PMID: 20639706 DOI: 10.1097/MPG.0b013e3181bb3362]

12 **Gilger MA**. Upper gastrointestinal bleeding. In: Walker WA, Goulet O, Kleinman RE, Sherman PM, Shneider BL and Sanderson IA (eds). Pediatric Gastrointestinal Disease, 4th ed. BC Decker Inc., 2004: 259-265

13 **Lee WS**, Zainuddin H, Boey CC, Chai PF. Appropriateness, endoscopic findings and contributive yield of pediatric gastrointestinal endoscopy. *World J Gastroenterol* 2013; **19**: 9077-9083 [PMID: 24379634 DOI: 10.3748/wjg.v19.i47.9077]

14 **Rafeey M**, Shoaran M, Majidy H. Diagnostic endoscopy and clinical characteristics of gastrointestinal bleeding in children: a 10-year retrospective study. *Iran Red Crescent Med J* 2013; **15**: 794-797 [PMID: 24616788 DOI: 10.5812/ircmj.7075]

15 **Mittal SK**, Kalra KK, Aggarwal V. Diagnostic upper GI endoscopy for hemetemesis in children: experience from a pediatric gastroenterology centre in north India. *Indian J Pediatr* 1994; **61**: 651-654 [PMID: 7721369]

16 **Septer S**, Cuffari C, Attard TM. Esophageal polyps in pediatric patients undergoing routine diagnostic upper gastrointestinal endoscopy: a multicenter study. *Dis Esophagus* 2014; **27**: 24-29 [PMID: 23551692 DOI: 10.1111/dote.12066]

17 **Isaacs KL**. Upper gastrointestinal tract endoscopy in inflammatory bowel disease. *Gastrointest Endosc Clin N Am* 2002; **12**: 451-462, vii [PMID: 12486938]

18 **Bhargava DK**, Arora A, Chopra P. Endoscopic polypectomies in upper gastrointestinal tract. *Indian J Gastroenterol* 1990; **9**: 41-42 [PMID: 2307500]

19 **Goenka AS**, Dasilva MS, Cleghorn GJ, Patrick MK, Shepherd RW. Therapeutic upper gastrointestinal endoscopy in children: an audit of 443 procedures and literature review. *J Gastroenterol Hepatol* 1993; **8**: 44-51 [PMID: 8439662]

20 **Arora NK**, Ganguly S, Mathur P, Ahuja A, Patwari A. Upper gastrointestinal bleeding: etiology and management. *Indian J Pediatr* 2002; **69**: 155-168 [PMID: 11929033]

21 **Karim B**. Upper gastrointestinal endoscopy in children - an experience at a paediatric gastroenterology unit. *Mymensingh Med J* 2003; **12**: 124-127 [PMID: 12894047]

22 **Lightdale JR**, Gremse DA. Gastroesophageal reflux: management guidance for the pediatrician. *Pediatrics* 2013; **131**: e1684-e1695 [PMID: 23629618 DOI: 10.1542/peds.2013-0421]

23 **El Mouzan MI**, Abdullah AM. The diagnosis of gastroesophageal reflux disease in children. *Saudi Med J* 2002; **23**: 164-167 [PMID: 11938391]

24 **de Jong AL**, Macdonald R, Ein S, Forte V, Turner A. Corrosive esophagitis in children: a 30-year review. *Int J Pediatr Otorhinolaryngol* 2001; **57**: 203-211 [PMID: 11223452]

25 **Kay M**, Wyllie R. Caustic ingestions and the role of endoscopy. *J Pediatr Gastroenterol Nutr* 2001; **32**: 8-10 [PMID: 11176317]

26 **Gupta SK**, Croffie JM, Fitzgerald JF. Is esophagogastroduodenoscopy necessary in all caustic ingestions? *J Pediatr Gastroenterol Nutr* 2001; **32**: 50-53 [PMID: 11176325]

27 **Thompson JN**. Corrosive esophageal injuries. I. A study of nine cases of concurrent accidental caustic ingestion. *Laryngoscope* 1987; **97**: 1060-1068 [PMID: 3306232]

28 **Temiz A**, Oguzkurt P, Ezer SS, Ince E, Hicsonmez A. Predictability of outcome of caustic ingestion by esophagogastroduodenoscopy in children. *World J Gastroenterol* 2012; **18**: 1098-1103 [PMID: 22416185 DOI: 10.3748/wjg.v18.i10.1098]

29 **Oracz G**, Pertkiewicz J, Kierkus J, Dadalski M, Socha J, Ryzko J. Efficiency of pancreatic duct stenting therapy in children with chronic pancreatitis. *Gastrointest Endosc* 2014; **80**: 1022-1029 [PMID: 24852105 DOI: 10.1016/j.gie.2014.04.001]

30 **Kieling CO**, Hallal C, Spessato CO, Ribeiro LM, Breyer H, Goldani HA, Maguilnik I. Changing pattern of indications of endoscopic retrograde cholangiopancreatography in children and adolescents: a twelve-year experience. *World J Pediatr* 2015; **11**: 154-159 [PMID: 25410666 DOI: 10.1007/s12519-014-0518-5]

31 **Hatlani MA**, Kortan P, May G, Ling SC, Walters T, Avitzur Y. Wire-guided cannulation versus contrast-guided cannulation in pediatric endoscopic retrograde cholangiopancreatography. *Saudi J Gastroenterol* 2015; **21**: 25-29 [PMID: 25672235 DOI: 10.4103/1319-3767.151219]

32 **Kramer RE**, Lerner DG, Lin T, Manfredi M, Shah M, Stephen TC, Gibbons TE, Pall H, Sahn B, McOmber M, Zacur G, Friedlander J, Quiros AJ, Fishman DS, Mamula P. Management of ingested foreign bodies in children: a clinical report of the NASPGHAN Endoscopy Committee. *J Pediatr Gastroenterol Nutr* 2015; **60**: 562-574 [PMID: 25611037 DOI: 10.1097/MPG.0000000000000729]

33 **Pinto A**, Lanza C, Pinto F, Grassi R, Romano L, Brunese L, Giovagnoni A. Role of plain radiography in the assessment of ingested foreign bodies in the pediatric patients. *Semin Ultrasound CT MR* 2015; **36**: 21-27 [PMID: 25639174 DOI: 10.1053/j.sult.2014.10.008]

34 **Peters NJ,** Mahajan JK, Bawa M, Chabbra A, Garg R, Rao KL. Esophageal perforations due to foreign body impaction in children. *J Pediatr Surg* 2015; pii: S0022-3468(15)00081-0 [PMID: 25783392 DOI: 10.1016/j.jpedsurg.2015.01.015]

35 **Alam E**, Mourad M, Akel S, Hadi U. A case of battery ingestion in a pediatric patient: what is its importance? *Case Rep Pediatr* 2015; **2015**: 345050 [PMID: 25692063 DOI: 10.1155/2015/345050]

36 **Costa L**, Larangeiro J, Pinto Moura C, Santos M. Foreign body ingestion: rare cause of cervical abscess. *Acta Med Port* 2014; **27**: 743-748 [PMID: 25641290]

37 **Pinto A**, Muzj C, Gagliardi N, Pinto F, Setola FR, Scaglione M, Romano L. Role of imaging in the assessment of impacted foreign bodies in the hypopharynx and cervical esophagus. *Semin Ultrasound CT MR* 2012; **33**: 463-470 [PMID: 22964412 DOI: 10.1053/j.sult.2012.06.009]

38 **Pattamanuch N**, Novak I, Loizides A, Montalvo A, Thompson J, Rivas Y, Pan D. Single-center experience with 1-step low-profile percutaneous endoscopic gastrostomy in children. *J Pediatr Gastroenterol Nutr* 2014; **58**: 616-620 [PMID: 24378575 DOI: 10.1097/MPG.0000000000000291]

39 **Khattak IU**, Kimber C, Kiely EM, Spitz L. Percutaneous endoscopic gastrostomy in paediatric practice: complications and outcome. *J Pediatr Surg* 1998; **33**: 67-72 [PMID: 9473103]

40 **Baker L**, Beres AL, Baird R. A systematic review and meta-analysis of gastrostomy insertion techniques in children. *J Pediatr Surg* 2015; **50**: 718-725 [PMID: 25783383 DOI: 10.1016/j.jpedsurg.2015.02.021]

41 **Gauderer MW**, Ponsky JL, Izant RJ. Gastrostomy without laparotomy: a percutaneous endoscopic technique. *J Pediatr Surg* 1980; **15**: 872-875 [PMID: 6780678]

42 **Temiz A**, Oguzkurt P, Ezer SS, Ince E, Gezer HO, Hicsonmez A. Management of pyloric stricture in children: endoscopic balloon dilatation and surgery. *Surg Endosc* 2012; **26**: 1903-1908 [PMID: 22234589 DOI: 10.1007/s00464-011-2124-0]

43 **Kukkady A**, Pease PW. Long-term dilatation of caustic strictures of the oesophagus. *Pediatr Surg Int* 2002; **18**: 486-490 [PMID: 12415387]

44 **Temiz A**, Oguzkurt P, Ezer SS, Ince E, Hicsonmez A. Long-term management of corrosive esophageal stricture with balloon dilation in children. *Surg Endosc* 2010; **24**: 2287-2292 [PMID: 20177917 DOI: 10.1007/s00464-010-0953-x]

45 **Lan LC**, Wong KK, Lin SC, Sprigg A, Clarke S, Johnson PR, Tam PK. Endoscopic balloon dilatation of esophageal strictures in infants and children: 17 years' experience and a literature review. *J Pediatr Surg* 2003; **38**: 1712-1715 [PMID: 14666449]

46 **Tekant G**, Eroğlu E, Erdoğan E, Yeşildağ E, Emir H, Büyükünal C, Yeker D. Corrosive injury-induced gastric outlet obstruction: a changing spectrum of agents and treatment. *J Pediatr Surg* 2001; **36**: 1004-1007 [PMID: 11431765]

47 **Treem WR**, Long WR, Friedman D, Watkins JB. Successful management of an acquired gastric outlet obstruction with endoscopy guided balloon dilatation. *J Pediatr Gastroenterol Nutr* 1987; **6**: 992-996 [PMID: 3681588]

48 **Sharma KK**, Ranka P, Goyal P, Dabi DR. Gastric outlet obstruction in children: an overview with report of Jodhpur disease and Sharma's classification. *J Pediatr Surg* 2008; **43**: 1891-1897 [PMID: 18926227 DOI: 10.1016/j.jpedsurg.2008.07.001]

49 **DiSario JA**, Fennerty MB, Tietze CC, Hutson WR, Burt RW. Endoscopic balloon dilation for ulcer-induced gastric outlet obstruction. *Am J Gastroenterol* 1994; **89**: 868-871 [PMID: 8198096]

50 **Kuwada SK**, Alexander GL. Long-term outcome of endoscopic dilation of nonmalignant pyloric stenosis. *Gastrointest Endosc* 1995; **41**: 15-17 [PMID: 7698619]

51 **Meier AH**, Mellinger JD. Endoscopic management of a duodenal duplication cyst. *J Pediatr Surg* 2012; **47**: e33-e35 [PMID: 23164028 DOI: 10.1016/j.jpedsurg.2012.07.035]

52 **DiMaio CJ**, Kamal N, Hogan CM, Midulla PS. Pediatric therapeutic endoscopy: endoscopic management of a congenital duodenal web. *Gastrointest Endosc* 2014; **80**: 166-167 [PMID: 24785127 DOI: 10.1016/j.gie.2014.03.006]

53 **Phalanusitthepha C**, Inoue H, Ikeda H, Sato H, Sato C, Hokierti C. Peroral endoscopic myotomy for esophageal achalasia. *Ann Transl Med* 2014; **2**: 31 [PMID: 25333007 DOI: 10.3978/j.issn.2305-5839.2014.02.04]

54 **Orenstein SB**, Raigani S, Wu YV, Pauli EM, Phillips MS, Ponsky JL, Marks JM. Peroral endoscopic myotomy (POEM) leads to similar results in patients with and without prior endoscopic or surgical therapy. *Surg Endosc* 2015; **29**: 1064-1070 [PMID: 25249143 DOI: 10.1007/s00464-014-3782-5]

55 **Ament ME**, Berquist WE, Vargas J, Perisic V. Fiberoptic upper intestinal endoscopy in infants and children. *Pediatr Clin North Am* 1988; **35**: 141-155 [PMID: 3277129]

56 **Thakkar K**, El-Serag HB, Mattek N, Gilger MA. Complications of pediatric EGD: a 4-year experience in PEDS-CORI. *Gastrointest Endosc* 2007; **65**: 213-221 [PMID: 17258979]

57 **Dumitriu D**, Menten R, Smets F, Clapuyt P. Postendoscopic duodenal hematoma in children: ultrasound diagnosis and follow-up. *J Clin Ultrasound* 2014; **42**: 550-553 [PMID: 24615821 DOI: 10.1002/jcu.22145]

58 **Borsaru AD**, Nandurkar D. Intramural duodenal haematoma presenting as a complication after endoscopic biopsy. *Australas Radiol* 2007; **51**: 378-380 [PMID: 17635478]

59 **Diniz-Santos DR**, de Andrade Cairo RC, Braga H, Araújo-Neto C, Paes IB, Silva LR. Duodenal hematoma following endoscopic duodenal biopsy: a case report and review of the existing literature. *Can J Gastroenterol* 2006; **20**: 39-42 [PMID: 16432559]

60 **Iqbal CW**, Askegard-Giesmann JR, Pham TH, Ishitani MB, Moir CR. Pediatric endoscopic injuries: incidence, management, and outcomes. *J Pediatr Surg* 2008; **43**: 911-915 [PMID: 18485965 DOI: 10.1016/j.jpedsurg.2007.12.036]

61 **Lalanne A**, Gottrand F, Salleron J, Puybasset-Jonquez AL, Guimber D, Turck D, Michaud L. Long-term outcome of children receiving percutaneous endoscopic gastrostomy feeding. *J Pediatr Gastroenterol Nutr* 2014; **59**: 172-176 [PMID: 24709828 DOI: 10.1097/MPG.0000000000000393]

62 **Huang SY**, Levine MS, Raper SE. Gastrocolic fistula with migration of feeding tube into transverse colon as a complication of percutaneous endoscopic gastrostomy. *AJR Am J Roentgenol* 2005; **184**: S65-S66 [PMID: 15728025]

63 **Johnston SD**, Tham TC, Mason M. Death after PEG: results of the National Confidential Enquiry into Patient Outcome and Death. *Gastrointest Endosc* 2008; **68**: 223-227 [PMID: 18329030 DOI: 10.1016/j.gie.2007.10.019]

64 **McClave SA**, Chang WK. Complications of enteral access. *Gastrointest Endosc* 2003; **58**: 739-751 [PMID: 14595312]

65 **Lee JH**, Kim JJ, Kim YH, Jang JK, Son HJ, Peck KR, Rhee PL, Paik SW, Rhee JC, Choi KW. Increased risk of peristomal wound infection after percutaneous endoscopic gastrostomy in patients with diabetes mellitus. *Dig Liver Dis* 2002; **34**: 857-861 [PMID: 12643294]

66 **Gubler C**, Wildi SM, Bauerfeind P. Liver injury during PEG tube placement: report of two cases. *Gastrointest Endosc* 2005; **61**: 346-348 [PMID: 15729264]

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**Table 1 Most common indications of diagnostic upper gastrointestinal endoscopy**

|  |
| --- |
| Caustic ingestionGastrointestinal bleedingDysphagia, odynophagia Recurrent or epigastric abdominal painFailure to thrive or weight lossVomiting Chronic or complicated GERDiarrhea or malabsorptionInvestigation for iron deficiency anemiaInflammatory bowel disease |

GER: Gastroesophageal reflux.

**Table 2 Most common detected pathologies in upper gastrointestinal bleeding**

|  |
| --- |
| Erosive esophagitisGastritisPeptic ulcer diseaseEsophageal varicesDuodenitis or duodenal ulcerMallory-Weiss tearsGastric erosionDieulafoy’s lesionAngioectasiaEsophageal or gastric polyps |

**Table 3 Typical indication of percutaneous endoscopic gastrostomy**

|  |
| --- |
| Inability to swallow Neurological impairment  Multiple congenital malformation Oropharyngeal dysmotility Epidermolysis bullosa Inadequate calorie intake Cystic fibrosis Congenital cardiac disease Chronic respiratory failureSpecial feeding requirementsContinuous enteral feedingOncologic diseaseGenetic syndromes |

**Table 4 Common complications of percutaneous endoscopic gastrostomy**

|  |
| --- |
| Failure of replacementWound infectionLocal erythemaCelulitisSepsisGastrointestinal bleedingGastric ulcerStomal leakageDeathGatrocolic fistulaTransient ileusGastroesophageal refluxPeritonitis Granulation tissueCatheter migrationHepatic injuryAortogastric fistulaSubcutaneous emphysema  |