

## Efficiency of upper gastrointestinal endoscopy in pediatric surgical practice

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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 the 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 worldwide for some UGI 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

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

Caustic ingestion
Gastrointestinal bleeding
Dysphagia or odynophagia
Recurrent or epigastric abdominal pain
Failure to thrive or weight loss
Vomiting
Chronic or complicated GER
Diarrhea or malabsorption
Investigation for iron deficiency anemia
Inflammatory bowel disease

GER: Gastroesophageal reflux.

size and flexibility of endoscopes, UGI endoscopy can be performed even on premature infants from the first day of birth with smaller endoscopes<sup>[1-5]</sup>. 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 cholangiopancreatography (ERCP), and peroral endoscopic myotomy (POEM) has gradually increased in children.

**DIAGNOSTIC ENDOSCOPY**

Dyspepsia, UGI bleeding and abdominal pain are the most common indications for diagnostic UGI endoscopy in pediatric surgical practice<sup>[3,4,6-10]</sup>. The indications are summarized in Table 1<sup>[1-3]</sup>. Because endoscopy is performed easily and quickly, the number of patients undergoing negative endoscopy increases gradually, which causes increased economic burden. However, as a result of this practice several new diseases and pathologies of the UGI system in childhood have been described<sup>[10]</sup>. There is still no definitive description of dyspepsia. Epigastric pain, fullness, vomiting, regurgitation, nausea, abdominal discomfort, and bloating are commonly accepted as dyspeptic symptoms<sup>[11]</sup>. Guariso *et al*<sup>[11]</sup> 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 mo 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 the esophagus, stomach and duodenum during endoscopy, especially from the 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

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

Erosive esophagitis
Gastritis
Peptic ulcer disease
Esophageal varices
Duodenitis or duodenal ulcer
Mallory-Weiss tears
Gastric erosion
Dieulafoy's lesion
Angioectasia
Esophageal or gastric polyps

listed in Table 2<sup>[3,12-15]</sup>. UGI bleeding affected only 5% of patients who underwent UGI endoscopy<sup>[12]</sup>. Although causes vary among reports, excessive UGI bleeding commonly arises from esophageal varices, peptic ulcer, gastritis, esophagitis or esophageal ulcer<sup>[3,13-15]</sup>. Polyps, inflammatory disorders, Dieulafoy's lesion or vascular malformations such as angioectasia are less common in children<sup>[3,16-19]</sup>. 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<sup>[15,20,21]</sup>.

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<sup>[22,23]</sup>. Because normal endoscopic appearance of the 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*<sup>[23]</sup> 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<sup>[24-26]</sup>. Upper gastrointestinal system 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<sup>[24-26]</sup>. It is usually recommended to stop endoscopy at the first circumferential esophageal burn because of the increased risk of complications beyond this point<sup>[27]</sup>. This approach might cause a more severely burned esophagus or

stomach to be missed. We observed severe gastric injury in 18.4% of patients; gastric injury was more severe than esophageal injury in 3.4% of patients in our study<sup>[28]</sup>. Therefore we suggest complete upper GIS endoscopy if possible in children with caustic injuries<sup>[28]</sup>. UGI 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<sup>[28]</sup>.

## 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<sup>[3,14,20]</sup>. 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<sup>[3,4]</sup>. Similarly, diagnosis of polyposis and polypectomy can be made as successive procedures<sup>[3,6]</sup>.

ERCP has been widely accepted as both a diagnostic and 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<sup>[29,30]</sup>. Complication rates of ERCP have been reported to be between 3.4% and 28.5%. The most common complications associated with ERCP are pancreatitis, hemorrhage, infection and perforation<sup>[30,31]</sup>. 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 UGI 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%) cases are reported as accidental events<sup>[32,33]</sup>. Coins are the most commonly ingested foreign body, which occurs in approximately 70% of cases<sup>[34]</sup>. However, toys, jewelry, magnets, and batteries are other commonly ingested foreign bodies<sup>[32]</sup>. 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<sup>[32,35,36]</sup>. Plain radiography is still the most used diagnostic modality. Barium meal study or computed tomography are indicated especially in cases

of ingestion of a non-contrast object or for patients with complications<sup>[33,37]</sup>. 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<sup>[37]</sup>. Foreign bodies detected in the stomach and intestines often tend to pass spontaneously<sup>[34]</sup>. The complication rates increase with pointed and sharp foreign bodies, button batteries, and magnets. Esophageal perforation has been detected in 2%-15% of patients with an esophageal foreign body in different studies<sup>[34]</sup>. 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<sup>[36]</sup>. 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 are ingested at different times, they may cling and cause intestinal perforation, peritonitis or enteroenteric fistula. For this reason, magnets should be removed as soon as they are identified<sup>[32]</sup>.

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.

### PEG

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*<sup>[38-41]</sup>. PEG is the most preferred technique especially for patients with neurological diseases<sup>[38]</sup>. However, Baker *et al*<sup>[40]</sup> revealed that there is increased risk of major complications of PEG compared to the laparoscopic gastrostomy<sup>[40]</sup>. The rate of complications

**Table 3 Typical indications 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 failure
Special feeding requirements
Continuous enteral feeding
Oncologic disease
Genetic syndromes

can be reduced by an experienced endoscopist. Indications of PEG are summarized in Table 3<sup>[38,39]</sup>.

**Operative technique:** The most preferred technique is the “pull” technique described by Gauderer<sup>[39,41]</sup>. Flexible endoscopy is performed using an appropriately sized endoscope. The stomach is insufflated. The optimal location for placement of the PEG is confirmed by 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<sup>[38,39]</sup>.

**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<sup>[42,43]</sup>. 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 strictures in children<sup>[44,45]</sup>. Endoscopically 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<sup>[44]</sup>.

Pyloric stricture (PS) may be caused by peptic ulcer,

granulomatous diseases and eosinophilic gastroenteritis, and caustic injury or unknown causes in children<sup>[46-48]</sup>. Diagnosis of PS is based on barium swallow. Endoscopic examination and biopsy of the UGI 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<sup>[42]</sup>. 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<sup>[49,50]</sup>.

**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<sup>[42]</sup>.

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<sup>[42]</sup>.

**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<sup>[51,52]</sup>. POEM has been described for achalasia in adults; clinical results of its use in children have been presented with small numbers of patients<sup>[53,54]</sup>.

**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<sup>[5]</sup>. Intestinal obstruction, neutropenia, severe thrombocytopenia, coagulopathy, recent gastrointestinal surgery, unstable cardiopulmonary diseases, and recent oral intake are accepted as relative contraindications<sup>[4,5]</sup>.

**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,

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

Failure of replacement
Wound infection
Local erythema
Celulitis
Sepsis
Gastrointestinal bleeding
Gastric ulcer
Stomal leakage
Death
Gastrocolic fistula
Transient ileus
Gastroesophageal reflux
Peritonitis
Granulation tissue
Catheter migration
Hepatic injury
Aortogastric fistula
Subcutaneous emphysema

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<sup>[5]</sup>. 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<sup>[4-9]</sup>. 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<sup>[4,8]</sup>. 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<sup>[1]</sup>. Under moderate sedation protective airway reflexes and spontaneous breathing remain active during endoscopy<sup>[5,9]</sup>. 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<sup>[55,56]</sup>. There are several complications associated with endoscopy or related procedures in the literature. Most are minor<sup>[55]</sup>. Complications are considered in two main groups. The first group is associated with anesthesia, such as delayed extubation, bronchospasm, and fever. Lee *et al*<sup>[13]</sup> 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<sup>[13,57-59]</sup>. Lee *et al*<sup>[13]</sup> observed secondary bleeding following rubber banding or sclerotherapy in 3.4% of patients. Iqbal *et al*<sup>[60]</sup> reported bleeding, perforation and mucosal tears as iatrogenic complications in 6 of 9308 UGI endoscopy procedures (0.06%). A conservative approach is usually sufficient for improvement in patients without peritonitis<sup>[60]</sup>.

### Complications of PEG

Complications due to PEG insertion or tube are divided into major and minor complications, summarized in Table 4<sup>[38,39,61-65]</sup>. Hepatic injury secondary to the PEG placement was reported in one adult. Peristomal wound infection accounts for 30% of complications<sup>[64,66]</sup>. 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<sup>[64,66]</sup>.

## CONCLUSION

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

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