REPORT
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Therapeutic pediatric upper endoscopy: a retrospective report from a low-volume center

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Author contributions
The study's conceptualization and design were led by EA, while data acquisition, analysis, and interpretation involved SA, LL, AZ, MB, and RA alongside EA, with NR, EA, and all authors contributing to manuscript revision, critical appraisal, and final approval.

Competing interests
The authors declare no conflicts of interest.

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Abbreviations
KAUH, King Abdullah University Hospital; PEG, percutaneous endoscopic gastrostomy; ESPGHAN, European Society for Pediatric Gastreoentrology, Hepatology and Nutrition; ASGE, American Society of Gastrointestinal Endoscopy; GI, gastrointestinal; UGIB, Upper GI bleeding.

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Abstract
Background: Pediatric endoscopy has become an essential diagnostic and therapeutic tool for a range of gastrointestinal conditions in children, according to published guidelines. This study aimed to assess the indications, outcomes, and complications of therapeutic endoscopy in children at King Abdullah University Hospital (KAUH) in Jordan. **Methods:** This study conducted a retrospective chart review of therapeutic endoscopic procedures, including esophageal dilation, variceal and non-variceal hemostasis, foreign body retrieval, and percutaneous endoscopic gastrostomy (PEG) Tube insertion, performed between January 2014 and December 2020 at the Gastrointestinal Endoscopy Unit (a mixed adult and pediatric unit) at KAUH. Demographic data, indications for intervention, comorbidities, procedural outcomes, postprocedural treatment, complications, readmission, and patient follow-up data were extracted from the patient's medical records. **Results:** During the study period, 185 patients underwent 260 therapeutic endoscopic procedures. 110 (60%) of the patients were boys. The average age of the patients was 81.8 ± 51.46 (standard deviation) months. Foreign body retrieval was the most common procedure, with accidental ingestion being the primary cause and coins being the most commonly impacted foreign body. Followed by esophageal dilatation and PEG tube insertion. Complications were mild and rare. **Conclusion:** The success rates and post-procedural complications of pediatric endoscopy procedures are similar between low- and high-volume hospitals worldwide, and procedural volume is not the only factor contributing to procedural outcomes and complication rates.

Keywords: pediatrics; endoscopy; gastrostomy; foreign body; esophagus; dilatation

Background

Pediatric endoscopy was first used in 1972 when Freemen employed a fiberoptic bronchoscope for upper gastrointestinal tract examinations in children and has been widely used since then. Subsequently, its use has developed rapidly owing to innovations in design, size, and specialized pediatric training, making it an essential diagnostic and therapeutic modality.

According to European Society of Pediatric Gastroenterology, Hepatology and Nutrition (ESPGHAN) guidelines, it is valuable for therapeutic management in a spectrum of pediatric gastrointestinal conditions such as foreign body ingestion, esophageal strictures, variceal and non-variceal hemostasis, and percutaneous endoscopic gastrostomy (PEG) tube placement [1]. On the other hand, the American Society of Gastrointestinal Endoscopy (ASGE) guidelines recommend such procedures to be performed by pediatric-trained endoscopists whenever possible [2].

Most of the literature reflects the experience of large volume centers. Where high number of cases are being operated regularly, such studies have shown that pediatric endoscopy can be performed safely with great health impact. A prospective study on 103 patients at a single tertiary-care pediatric hospital in the United States showed successfully placed percutaneous gastrostomy tubes (PEGs) for patients with feeding difficulties with no procedure-related deaths and a complication rate of 14% [3]. Similarly, a retrospective cohort of 368 patients who underwent PEG placement at a tertiary hospital in France was evaluated for long-term complications of PEG, and it demonstrated that 85% of the population had only minor complications such as granulation tissue and local erythema with improved nutritional and growth status [4]. Moreover, a total of 2637 patients with foreign body ingestion were treated with flexible or rigid endoscopes at the Department of Chest Surgery and Endoscopy of a tertiary hospital in Spain with a 7.8% rate of post-procedure complications [5]. In a similar vein, a Polish study revealed that 11 Polish pediatric endoscopy centers performed 10,650 of them, including 347 esophageal dilation procedures, in 2010 [6]. Only a minority had post-procedure complications, including bleeding during the procedure that was not serious and did not need intervention and one case of esophageal perforation. A total of 69 children were treated for esophageal strictures in Taiwan with endoscopic balloon dilation; the procedure had a clinical success rate of 72% and only 2.6% post-procedural complications [7].

Variceal ligation is used both as a therapeutic and prophylactic measure in children with portal hypertension. A Spanish study reported the outcome of 24 patients with portal hypertension who underwent variceal ligation; the authors concluded that esophageal variceal ligation is safe and effective in preventing gastrointestinal bleeding [8].

On the other side, studies from developing countries have also shown good outcomes with minimal complications, as seen in a retrospective study on 39 children who had PEG-tube placement in Saudi Arabia. It showed that 51% of the patients did not have any complications, while the remaining had minor complications, including infection, granulation, leakage, and tube dislodgement, and only one case developed cellulitis [9]. A Nigerian study analyzed the outcomes of 108 foreign body retrieval procedures at a University Teaching Hospital, with 18.5% of patients developing complications including hemorrhage, perforation and aspiration pneumonia [10]. Additionally, another Saudi retrospective study at King Khalid University Hospital showed the outcomes of endoscopic dilation for esophageal strictures in 43 patients, which resulted in complete resolution of symptoms without the need for further dilation in 67% of patients and partial symptom improvement in 30.2% [11].

There are significant variations between low and high-volume hospitals across the world due to the economic constraints that limit the availability of pediatric endoscopy units, advanced pediatric interventions, and pediatric-specific training for the use of endoscopy in children. Low-volume centers are underrepresented in literature in regard to both epidemiological and success rates. This study aimed to evaluate the indications, outcomes, and complications of pediatric therapeutic endoscopy procedures performed in the endoscopy unit of King Abdullah University Hospital (KAUH), Irbid, Jordan.

Methods and analysis

Study Setting

Our hospital is the tertiary university hospital for North Jordan. The endoscopy unit in our hospital is a mixed unit (Pediatric and Adult), whereas another two endoscopy units in North Jordan offer pediatric endoscopy; our unit is the only one to offer therapeutic intervention. The procedures were performed by two pediatric gastroenterologists. Patients admitted to the endoscopy unit through either emergency bases (foreign body ingestion, bleeding) or scheduled intervention (esophageal dilatation, PEG-tube insertion). The patients underwent the procedures under light sedation (intravenous midazolam) or heavy sedation (ketamine/fentanyl). General anesthesia was administered on a case-specific basis.

Study type

A retrospective chart review of all pediatric therapeutic upper endoscopic procedures. All patients underwent any therapeutic endoscopic intervention, including esophageal dilation, variceal and non-variceal hemostasis, foreign body removal, and PEG tube insertion, performed between January 2014 and December 2020 in the Gastrointestinal Endoscopy Unit at KAUH.

Data collection

Patients were identified. Electronic medical records were retrieved and reviewed. Demographic data, including age, sex, type of procedure, indication, and outcome, was collected.

Details of procedures (indication, sedation, presence of comorbidities, procedural outcomes, post-procedural treatment, complications (medical or the need for surgical intervention), readmission, need for repeat the procedure, and patient follow-up.

We also collected data specific to the procedures (e.g., site of stricture, cause, size of dilators, type of foreign body, and site of sticking, bleeding, perforation, tube–related issues). Data was entered into a pre-prepared Excel sheet. In the case of repeated procedures, each one is considered a separate procedure for the purpose of data analysis.

Exclusion criteria

Patients older than 18 years at the time of the first procedure
Patients who underwent non-therapeutic endoscopic procedures
Patients who underwent therapeutic procedures during colonoscopy (polypectomy and securing hemostasis).
Patients who had therapeutic intervention outside our facility.

Data analysis

The data were analyzed using R programming software (R 2.14.2; R Foundation for Statistical Computing, Vienna, Austria). Descriptive data were reported as percentages of the total categorical data and as means ± standard deviation.

Ethics and dissemination

This study was approved by the Institutional Review Board (IRB) of the Faculty of Medicine and Research Committee of Jordan University of Science and Technology (20190077). The data set will be available through the corresponding author.

Results

During the study period, a total of 185 patients underwent 260 episodes of therapeutic endoscopic procedures. These included 110 (59.5%) males with a mean age of 81.8 ± 51.46 (standard deviation) months. These procedures included foreign body retrieval (71.4%), esophageal dilation (13.5%), PEG tube placement (11.4%), variceal

bleeding hemostasis (3.2%), and non-variceal bleeding hemostasis (1.1%). These are shown in Table 1.

The most common procedure performed was foreign body retrieval due to accidental foreign body ingestion (92.4%), with a mean age of 79.1 ± 39.9 months at endoscopy. The most commonly impacted foreign body was coins (93 (70.4%)), and the main locations of the foreign bodies were the esophagus (76.5%) and stomach (21%); none were located in the duodenum. The second most impacted common foreign body was food (14 (10.6%)), followed by metallic items (9 (6.8%)). These are shown in Table 2.

Esophageal dilation was indicated for upper esophageal strictures (68%), primarily caused by caustic injury (36%), congenital esophageal strictures (20%), and eosinophilic esophagitis (16%). The procedure was not complicated by bleeding or perforations. Approximately half of the patients were admitted to the hospital for postprocedural observation. Most patients were treated with endoscopic Bougie dilators (76%) and required more than three dilation sessions (48.0%). These findings are shown in Table 3.

During the study period, 22 patients underwent a percutaneous endoscopic gastrostomy tube (PEG) insertion. The most common indication for PEG tube placement was feeding difficulty (59%), followed by recurrent aspiration and failure to thrive (45.4%). Most of the patients had neurological disorders (77.3%). All 22 patients who underwent PEG tube placement showed symptom improvement. Mild complications (site infection, leakage, blockage, and formation of granulation tissue requiring chemical cauterization) were observed in seven patients (31.8%). These results are shown in Table 4.

Lastly, the least commonly performed procedures were the hemostatic procedures (for variceal and non-variceal bleeding). A total of 13 variceal ligations and two ulcer injections were performed in addition to gold probe usage. Hemostasis was achieved without any complications. Two patients required transfusions of blood and blood products upon presentation (Table 5).

Table 1 Demographics and types of interventions

Intervention	Esophageal Dilation (n = 25)	Variceal bleeding hemostasis (n = 6)	Non-variceal bleeding hemostasis (n = 2)	Foreign body retrieval (n = 132)	PEG tube insertion (n = 22)	Total
Age at endoscopy (months) Mean (SD)	72.2 (51.4)	180 (30.4)	72.7 (51.4)	79.1 (39.9)	75.0 (61.7)	81.8 (51.46)
Sex						
Male	17 (53.1%)	2 (33.3%)	1 (50%)	79 (59.8%)	11 (42.3%)	110 (59.5%)
Female	8 (25.0%)	4 (66.7%)	1 (50%)	53 (40.2%)	11 (42.3%)	75 (40.5%)
Outcome						
Improved	24 (96.0%)	6 (100%)	2 (100%)	---	19 (73.1%)	
Post-procedure Complications	0 %	0%	0%	0%	7 (30%)	

Table 2 Details of Foreign body ingestion cases

Sex	
Male	79 (59.8%)
Female	53 (40.2%)
Age at Endoscopy (months)	
Mean (SD)	79.1 (39.9)
Median [Min, Max]	72.0 [9.00, 192]
Presenting complaint:	
Asymptomatic/noticed ingestion	
Vomiting	18 (13.6%)
Dysphagia	12 (9.1%)
GI bleeding	2 (1.5%)
Respiratory symptoms	11 (8.3%)
Gagging and drooling	12 (9.1%)
Food/Foreign body ingestion	
Foreign body	118 (90.2%)
Food	14 (10.6%)
Type of foreign body	
Food	14 (10.6%)
Coin	94 (70.4%)
Metallic body	9 (6.8 %)
Plastic piece	2 (1.5%)
Battery	3 (2.3%)
Tool clipper	1 (0.8%)
Needle	1 (0.8%)
Pin	6 (4.5%)
Marble ball	2 (1.5%)
Site of impaction	
Esophagus	101 (76.5%)
Stomach	28 (21.2%)
Duodenum	0 (0%)

Table 2 Details of Foreign body ingestion cases (*Continued*)

Sex	
Underlying cause of impaction	
No underlying pathology (accidental)	122 (92.4%)
Eosinophilic esophagitis (EoE)	9 (6.8%)
Stricture	1 (0.8%)
Type of intervention used in retrieval	
Food	14 (10.6%)
Coin	94 (70.4%)
Metallic body	9 (6.8 %)
Plastic piece	2 (1.5%)
Battery	3 (2.3%)
Tool clipper	1 (0.8%)
Needle	1 (0.8%)
Pin	6 (4.5%)
Marble ball	2 (1.5%)
Site of impaction	
Esophagus	101 (76.5%)
Duodenum	0 (0%)
Underlying cause of impaction	
No underlying pathology (accidental)	122 (92.4%)
Eosinophilic esophagitis (EoE)	9 (6.8%)
Stricture	1 (0.8%)
Type of intervention used in retrieval	
Pushed to stomach	10 (7.6%)
Forceps (Rat tooth forceps, Roth net forceps)	122 (92.4%)
Outcome	
Pushed to stomach	6 (4.5%)
Retrieved	123 (93.2%)
Not found	3 (2.3%)
Sedation	
Yes	16 (12.1%)
No	102 (77.3%)
Type of sedation	
Midazolam	8 (6.1%)
Diazepam	1 (0.8%)
Ketamine/Midazolam	4 (3%)
Local anesthesia (Lidocaine)	2 (1.5%)
General anesthesia	1 (0.8%)
Biopsies	
Yes	5 (3.8%)
No	126 (95.5%)
Treatment after the intervention	
Proton Pump Inhibitors	11 (8.3%)
Antibiotics	1 (0.8%)
Corticosteroids	1 (0.8%)
H2 Blockers	2 (1.5%)
None	114 (86.4%)
Inpatient/Outpatient	
Inpatient	45 (34.1%)
Outpatient	87 (65.9%)
Post procedure admission	11 (8.3%)
Post procedure complications	0 (0%)
Aspiration Pneumonia	0 (0%)

Table 3 Details of patients underwent esophageal dilatation

Cases of esophageal dilations	Overall
	(N = 25)
Sex	
Male	17 (68.0%)
Female	8 (32.0%)
Age at Endoscopy (months)	
Mean (SD)	72.2 (51.4)
Median [Min, Max]	48.0 [9.00, 168]

Table 3 Details of patients underwent esophageal dilatation (*Continued*)

Cases of esophageal dilations	Overall
Cause of stricture	
Peptic	3 (12%)
Caustic	9 (36%)
Eosinophilic esophagitis (EoE)	4 (16%)
Anastomosis	4 (16%)
Congenital	5 (20%)
Site of stricture	
Upper esophagus	17 (68%)
Middle esophagus	7 (28%)
Lower esophagus	1 (4%)
Vomiting	13 (52%)
Dysphagia	14 (56%)
GI bleeding	1 (4%)
Respiratory symptoms	6 (24%)
Growth impairment	5 (20%)
Anemia	10 (40%)
Type of dilators	
Balloon	6 (24%)
Bougies	19 (76%)
Number of dilations	
1	7 (28%)
2	6 (24%)
>3	12 (48%)
Barium Imaging	6 (24%)
Sedation	
Yes	19 (76%)
No	6 (24%)
Biopsies	
Yes	8 (32.0%)
No	16 (64.0%)
Outcome	
Improved	25 (100%)
Comorbidities	
Autism	1 (4%)
Tracheoesophageal fistula	2 (8%)
Hypoxic Ischemic Encephalopathy	2 (8%)
Glycogen storage disease	1 (34%)
Gastroesophageal reflux	2 (8%)
Esophagogastric anastomosis	1 (4%)
Inpatient/Outpatient	
Inpatient	18 (72.0%)
Outpatient	7 (28.0%)
Post procedure admission	11 (44%)
Post procedure complications	0 (0%)

Table 4 Details of patients` with PEG tube insertion

Case of PEG tube insertion	Overall
	(N = 22)
Sex	
Male	11 (50%)
Female	11 (50%)
Age at Endoscopy (months)	
Mean (SD)	75.0 (61.7)
Median [Min, Max]	54.0 [4.00, 192]
Vomiting	9 (40.9%)
Dysphagia	6 (27.3%)
GI bleeding	2 (9%)
Recurrent aspiration	10 (45.4%)
Failure to thrive	10 (45.4%)
Anemia	9 (40.9%)
Feeding difficulties	13 (59%)
Cause of insertion	
Neurological	17 (77.3%)
Syndromic	2 (9%)
Respiratory	3 (13.6%)
Size of tube	

Table 4 Details of patients` with PEG tube insertion (*Continued*)

Case of PEG tube insertion	Overall
18Fr	2 (9%)
20Fr	1 (4.5%)
24Fr	18 (81.8%)
Sedation	
Yes	13 (59%)
No	9 (40.9%)
Type of sedation	
Midazolam	10 (45.4%)
Ketamine	1 (4.5%)
Ketamine/Midazolam	1 (4.5%)
Fentanyl/Midazolam	1 (4.5%)
None	9 (40.9%)
Biopsies	
Yes	3 (13.6%)
No	19 (86.4%)
Outcome	
Improved	22 (100%)
Inpatient/Outpatient	
Inpatient	18 (81.8%)
Outpatient	2 (9%)
PEG tube placement	
Yes	10 (45.4%)
No	12 (54.5%)
Comorbidities	
Neurological	15 (68.2%)
Respiratory	1 (4.5%)
Neurological/Respiratory	3 (13.6%)
Metabolic/Cardiac	2 (9%)
None	1 (4.5%)
Treatment	
Antibiotic	2 (9%)
Proton Pump Inhibitors (PPI)	4 (18.2%)
Triple therapy	1 (4.5%)
None	14 (63.6%)
Post procedure admission	
Yes	18 (81.8%)
No	4 (18.2%)
Post procedure complications	
Yes	0 (0.0%)
No	22 (100%)
Chronic complications	
Infection	3 (13.6%)
Leakage	2 (9%)
Granulation	1 (4.5%)
Blockage	1 (4.5%)
None	15 (68.2%)

Table 5 Details of patients underwent esophageal variceal ligation

Cases of esophageal varices	Overall
	(N = 6)
Sex	
Male	2 (33.3%)
Female	4 (66.7%)
Age at Endoscopy (months)	
Mean (SD)	180 (30.4)
Median [Min, Max]	186 [144216]
Vomiting	1 (16.7%)
Dysphagia	0 (0%)
GI bleeding	2 (33.3%)
Respiratory symptoms	1 (16.7%)
Growth impairment	1 (16.7%)
Anemia	4 (66.7%)
Site of esophageal varices	
Upper esophagus	0 (0%)
Middle esophagus	0 (0%)
Lower esophagus	6 (100%)

Table 5 Details of patients underwent esophageal variceal ligation (*Continued*)

Cases of esophageal varices	Overall
Extension of varices	
Yes	2 (33.3%)
No	3 (50%)
Cause of esophageal varices	
Autoimmune hepatitis	1 (16.7%)
Budd Chiari Syndrome	1 (16.7%)
Portal vein thrombosis	1 (16.7%)
Liver cirrhosis	3 (50%)
Type of intervention used for bleeding	
Band Ligation	6 (100%)
Injection therapy	0 (0%)
Number of sessions	
1	2 (33.3%)
2	2 (33.3%)
3	1 (16.7%)
4	1 (16.7%)
Outcome	
Improved	6 (100%)
Relapsed	0 (0%)
Surgery	0 (0%)
Sedation	
Yes	6 (100%)
No	0 (0%)
Type of sedation	
Midazolam	3 (50%)
Ketamine	2 (33.3%)
Fentanyl/Midazolam	1 (16.7%)
Biopsies	
Yes	0 (0%)
No	6 (100%)
Treatment after the intervention	
Proton Pump Inhibitors (PPI)	1 (16.7%)
PPI/ B blocker	2 (33.3%)
PPI/octreotide	1 (16.7%)
PPI/Octreotide/Antibiotics	1 (16.7%)
B blockers/PPI/vitamin K/octreotide	1 (16.7%)
Transfusion	
Platelets-Fresh frozen plasma	1 (16.7%)
Packed red blood cells (PRBCS)	0 (0%)
None	5 (83.3%)
Inpatient/Outpatient	
Inpatient	5 (83.3%)
Outpatient	1 (16.7%)
Post procedure admission	
Yes	6 (100%)
No	0 (0%)
Post procedure complications	
Yes	0 (0%)
No	6 (100%)
Aspiration Pneumonia	0 (0%)
Rebleeding	0 (0%)

Discussion

Upper gastrointestinal (GI) endoscopic procedures, including esophagogastroduodenoscopy, hemostatic therapy, balloon dilation, and percutaneous endoscopic gastrostomy (PEG) tube placement, are commonly performed to manage pediatric digestive conditions. This study aimed to assess the use of GI endoscopy in an endoscopy unit at KAUH.

According to our data, the most common indication for pediatric therapeutic endoscopy is foreign body retrieval (50.7%), followed by esophageal dilation (35%), PEG tube placement (8.5%), esophageal varices bleeding (5%), and non-variceal upper GI bleeding (0.8%), which is consistent with what is described in the North American Society for Pediatric Gastroenterology, Hepatology, and Nutrition /American Society for Gastrointestinal Endoscopy (ASGE) guidelines [1, 2].

Foreign body retrieval is mostly indicated for symptomatic patients with different presentations such as vomiting, dysphagia, drooling, and respiratory symptoms. The most common type of ingested foreign body was blunt objects, specifically coins (69.7%), followed by food (9.8%). This is similar to what was reported in a retrospective study of 273 children who underwent foreign body removal at the University of Alabama Birmingham Hospital, which showed that the most common presentations of foreign body ingestion were drooling, dysphagia, and foreign body sensation. Coins were the most commonly ingested (78%), followed by bottle caps (3.7%) [12]. Another study of 194 episodes of foreign body ingestion at Chiang Mai University (CMU) in Thailand showed that 55.67% of patients were symptomatic, with vomiting, dysphagia, and foreign body sensation as

the most common symptoms. Coins (41.24%) were the most commonly ingested foreign body, followed by food boluses (15.46%) [13]. In our study, the most common site of impaction was the esophagus (73.5%), followed by the stomach (19.7%). These findings are similar to those of previous studies where the esophagus was the most common site of impaction [1, 2, 12, 13]. In 78.8% of the cases, foreign body retrieval was retrieved using flexible endoscopy and rat-tooth forceps, according to the European Society of Gastrointestinal Endoscopy/ESPGHAN guidelines [1, 2]. The remaining foreign body was pushed into the stomach. It is important to mention that 91.7% of foreign body ingestion episodes were accidental, 6.8% were due to eosinophilic esophagitis, and only one case of stricture was reported. However, no episodes of postprocedural complications or aspiration pneumonia were reported. Previous studies show four (2.1%) episodes of postprocedural complications and one case of aspiration pneumonia [12]. Another study reported a 3.2% minor post-procedural complication rate, with minor complications being recurrent emergency room or clinic visits due to vomiting [13]. A retrospective study on 64 patients reported that the most common foreign body was coins, with the second most common being pins. These patients most frequently presented with dysphagia and parental recognition of the ingested body. Most foreign bodies impact the upper esophagus without complications [14]. Moreover, a 10-year retrospective study of 248 children who underwent endoscopic foreign body retrieval found that 81% of the foreign bodies retrieved were coins, which were mostly retained in the upper esophagus (68%). Eleven (5.5%) patients were found to have an underlying pathology, including strictures, reflux esophagitis, erosive esophagitis, or eosinophilic esophagitis, with no post-procedural complications [15].

Esophageal strictures are common indications for therapeutic endoscopy in children. According to the North American Society for Pediatric Gastroenterology, Hepatology, and Nutrition and the American Society for Gastrointestinal Endoscopy (ASGE), most strictures in children are non-malignant [1, 2]. The causes of strictures in children include surgical repair of esophageal atresia, peptic injury, eosinophilic esophagitis, congenital lesions, Schatzki rings, achalasia, and caustic injury [1, 2].

In our cohort, the most common indication for esophageal strictures was caustic injury, with symptoms such as dysphagia, vomiting, and anemia. Our patients required a median of seven dilation sessions, with 12 patients requiring more than three sessions. These findings are consistent with the literature regarding the sites of esophageal strictures, which are typically found in the upper third of the esophagus.

A multi-center study by Pieczarkowski et al. found that the most frequent causes of esophageal strictures reported by Polish centers were postoperative strictures, followed by chemical esophageal burns and post-inflammatory strictures [6]. In a separate study, Chang et al. found that anastomotic strictures secondary to surgical repair, alkaline corrosive injury, and achalasia were the most common causes of esophageal strictures. Patients with achalasia mostly presented with vomiting (60%) and dysphagia (42%), whereas the strictures were mostly found in the upper (30%) and middle (22%) thirds of the esophagus [16].

A multi-center Polish study showed that balloon dilators were used in seven of eleven centers, with only four centers using rigid dilators without a guidewire [6]. The study also found that one dilation session was sufficient for only 10% of the patients, while (90%) of them required 2–6 sessions or more. This study reported only one case of perforation in 347 patients (0.28%). In contrast, Chang et al. reported a perforation rate of 2.6% after endoscopic balloon dilatation. Management failure is associated with multiple-site or long-segment esophageal strictures after alkaline corrosive injury [16].

In our study, Bougie dilators were the most frequently used (76%), with a minority of patients treated with balloon dilators. We found no difference between the two methods in terms of the number of dilation sessions required to relieve symptoms or procedure-related complications. Although our cohort showed no cases of postoperative complications, specifically perforations, the small number of cases limited any conclusions.

The literature lacks consensus on whether balloon dilators are superior to Bougie dilators in patients with benign esophageal strictures. Previous studies have shown that there is no significant difference between the two options in terms of post-procedure complications, specifically perforation or the number of repeated dilation sessions required [17–19]. A recent systematic review comparing the efficacy of balloon and Bougie dilators in treating strictures caused by Eosinophilic Esophagitis (EoE) found no difference between the two methods [18]. However, Lang et al. showed that patients treated with balloon dilators required 1–7 dilation sessions (median of 2) in 1–18 months, while patients treated with Bougie dilators required 3–60 sessions (median of 42). They concluded that balloon dilators were more effective in relieving symptoms and reducing hospitalization time [20]. Notably, Bougie dilators are more cost-effective because they are reusable, unlike balloon dilators, which are for single use only [17]. Further prospective trials are needed to evaluate the outcomes, but we can say that the endoscopist's experience and complexity are the main contributors to success and complication rates.

Enteral tube placement is the preferred method to increase the caloric intake of patients who are unable to eat by mouth [1, 2]. In our study, neurological conditions were most frequently indicated. Generally, children experience feeding difficulties, recurrent aspirations, and failure to thrive, as previously reported [4, 21]. Eight percent of the children had no acute postprocedural complications, but 8 of 22 (46.2%) had mild chronic complications such as infection, leakage, granulation, and blockage. A prospective study of 103 patients at a single tertiary care pediatric hospital in the United States showed successfully placed tubes (PEGs) with no procedure-related deaths and a complication rate of 14%, including surgical site infection and dislodgment [21]. Lalanne et al. evaluated the long-term complications of PEG and demonstrated that 85% of the population had only minor complications, such as granulation tissue and local erythema, with improved nutritional and growth statuses [20].

Upper GI bleeding (UGIB) is uncommon in the pediatric population but is life-threatening [1, 2, 22, 23]. The causes of UGIB can be categorized based on age or source, such as variceal or non-variceal bleeding. In our cohort, variceal esophageal bleeding was commonly caused by liver cirrhosis. It is well known in the literature that UGIB, due to varices, is more common in developing countries and Asia and presents mainly with anemia. The patients were treated with endoscopic band ligation, which is the treatment of choice for variceal bleeding, and there were no post-procedural complications. Most patients did not require more than two sessions [22, 23].

Non-variceal bleeding is commonly caused by peptic ulcer disease, with vomiting, hematemesis, and anemia being the most common symptoms observed in our study. The patient was treated with adrenaline injections in a single session and showed improvement without any complications.

Consistent with previous studies and current guidelines, upper endoscopic procedures are typically performed under general anesthesia to ensure patient safety, reduce anxiety, and facilitate cooperation [1, 2, 6, 14, 16, 19, 24]. However, conscious sedation could be safely performed. In our cohort, most patients received moderate sedation with midazolam and ketamine, and the procedures were completed without complications or patient disturbances. Thus, we recommend moderate sedation when general anesthesia is not available.

Our study is limited by its retrospective design and small sample size in some procedures owing to its rarity.

Although there are significant differences in the availability of pediatric endoscopy units, advanced pediatric interventions, and pediatric-specific training between low- and high-volume hospitals worldwide, the above discussion suggests that success rates and post-procedural complications are nearly identical. Barakat et al. conducted a population-based study of pediatric Endoscopic

Retrograde Cholangiopancreatography (ERCP) procedures performed in the United States, an advanced endoscopic procedure, and found that procedural volume could predict the outcome of ERCP interventions. Patients treated at high-volume urban teaching hospitals had shorter hospital stays than those treated at low-volume rural hospitals [25].

Limitations

Such a retrospective study with a small number of cases presents certain limitations that should be acknowledged. Firstly, the limited sample size leads to difficulty in generalizing findings to larger populations, as the sample may not adequately represent larger patient groups. Additionally, with a smaller dataset, there's an increased risk of selection bias, as the cases included may not be fully representative of the overall patient population, potentially skewing the results. Therefore, while this retrospective study provides valuable insights, the constraints imposed by a small number of cases necessitate a cautious interpretation of the findings and emphasize the need for further research with larger, more diverse samples to confirm and extend the conclusions drawn. This can be overcome by a prospective multi-center study at the national level for better representation.

In conclusion

Utilizing therapeutic endoscopy in pediatric patients within low-volume medical centers presents a unique set of challenges and considerations. These centers often have limited exposure to complex endoscopic procedures in children, which can potentially impact both the competency of the medical team and the availability of specialized equipment tailored to pediatric cases. Nevertheless, it's crucial to note that small-volume centers can play a valuable role in expanding access to care, particularly in underserved regions. To ensure safe and effective therapeutic endoscopy for children in such centers, it is essential to prioritize ongoing training and education for healthcare providers, establish robust referral networks to higher-volume centers when necessary, and adhere closely to established pediatric endoscopy guidelines. Thus, smaller and less frequently utilized medical centers should not disregard the performance of therapeutic procedures solely based on the number of procedures they carry out. By doing so, low-volume centers can contribute to delivering high-quality care to pediatric patients while continuously improving their expertise in therapeutic endoscopy.

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