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ORIGINAL ARTICLE

Characteristics and Diagnostic Yield of Pediatric Colonoscopy in Taiwan

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Key Words
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lower gastrointestinal bleeding

Background: Colonoscopy of the lower gastrointestinal tract has diagnostic and therapeutic value. This retrospective study aimed to investigate the indications, complications, and diagnostic yield of diagnostic colonoscopy among Taiwanese children.
Methods: The application of colonoscopy performed on children aged < 18 years between 1998 and 2010 in a referral tertiary center in Southern Taiwan was reviewed. Data on age, gender, indications, complications, and colonoscopic and final diagnoses were collected and analyzed.
Results: One hundred and ninety-two children with 201 colonoscopies and 27 sigmoidoscopies were enrolled. The rate of successful ileocecal approach was 77.5%. The most common indication was lower gastrointestinal bleeding (LGIB; 53.5%), followed by chronic abdominal pain (20.6%), iron deficiency anemia (IDA; 11.8%), and chronic diarrhea (11.4%). There were 144 patients (75%) with a conclusive diagnosis in their first colonoscopy, including nonspecific colitis (23.4%), polyp (20.4%), and inflammatory bowel disease (8.3%). The diagnostic yields of colonoscopy according to the major indications were 77.3% in LGIB, 68.1% in chronic abdominal pain, 66.7% in IDA, and 79.2% in chronic diarrhea. Among the patients with LGIB, juvenile polyp (26.4%) was the most common etiology. There were no major procedure-related complications.
Conclusion: LGIB is the most common indication for pediatric colonoscopy. Pediatric colonoscopy is most effective in diagnosing pediatric LGIB and chronic diarrhea.

1. Introduction

Pediatric fiber optic colonoscopy was introduced in the 1970s. Since then, improvements in fiber optic and video technology, conscious sedation, and physicians' experience have led to the establishment of colonoscopy as a procedure for the diagnosis, evaluation, and management of lower gastrointestinal tract disorders in children.[1–4]

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Colonoscopy is technically more challenging than esophagogastroduodenoscopy, especially in pediatric patients, due to their poor compliance and cooperation.[5] The development of pediatric colonoscopy in Taiwan began in the late 1970s, and both diagnostic and therapeutic colonoscopies are now widely performed by most pediatric gastroenterologists.

Despite the generally increased use of colonoscopy in pediatric patients, careful selection of the indications for colonoscopy in these patients can still achieve higher diagnostic yields and prevent complications. The most common indications are unexplained iron deficiency anemia (IDA), lower gastrointestinal bleeding (LGIB), and diarrhea.[6] However, the diagnostic yield varies depending on the indication, with unexplained diarrhea and blood in the stools having the highest diagnostic yield (91—97%).[7,8] Therapeutic colonoscopy is most frequently applied in children for polypectomy and for bleeding,[9,10] with successful resection rates exceeding 96% for polypectomy.[2,11,12]

With the rapidly increasing number of colorectal polyps, polypectomy has also become the most common endoscopic procedure in adults. Although the potential for malignant change of colorectal polyps in children is rare, symptomatic colorectal polyps are not uncommon, especially in those with LGIB.[13—15] However, available data regarding the prevalence, clinical features, and significance of colonoscopy in the evaluation of colorectal polyps in children remain limited. This retrospective study aimed to investigate the indications, complications, and diagnostic yield of pediatric colonoscopy, and the prevalence and clinical characteristics of colorectal polyps in children.

2. Methods

2.1. Participants enrolled, data collected, and definitions

The application of diagnostic colonoscopy in consecutive children aged < 18 years between 1998 and 2010 at National Cheng Kung University Hospital, a tertiary referral center in Southern Taiwan, was reviewed. Data were collected from the hospital's electronic database system. Demographic data, indications for colonoscopy, final diagnosis, and complications were recorded and analyzed. A positive diagnostic yield was defined as colonoscopic and/or histologic findings leading to a conclusive diagnosis that corresponded with the symptoms. Nonspecific colitis was defined as colonoscopic features showing erosive or erythematous mucosal lesions combined with lymphocytic infiltration in histologic examinations. Major complications were defined as complications related to the procedure that led to prolonged admission, morbidity, or mortality. The hospital's Ethical Committee approved the study protocol.

2.2. Colonoscopy preparation and procedure

Each patient had a bowel preparation of low residue diet for 2 days prior to examination, followed by either oral castor oil (dosage: > 2 years, 5—15 mL; < 2 years, 1—5 mL), and suppository bisacodyl (dosage: > 10 years, 10 mg; < 10 years, 5 mg) on the night before the examination, or oral sodium phosphate (dosage: > 12 years, 20—45 mL; 10—11 years, 10—20 mL; 5—9 years, 5—10 mL) with liquid in the night and on the day before the examination.[16] Bowel-cleansing enemas were also performed on the day of the examination. Intravenous or intramuscular meperidine (dosage: 2 mg/kg, maximum 50 mg) and hyoscine butyl bromide (0.5 mg/kg, maximum 20 mg) were given 30 minutes prior to the examination. Patients who were not cooperative or tolerant during the examination received conscious sedation with intravenous midazolam (single dose 0.2 mg/kg) and propofol (single dose 2.5 mg/kg for induction of anesthesia, with a bolus dose of 5—10 mg if needed).[17,18] Under conscious sedation, the patients were given oxygen supplementation via nasal cannula and monitored by pulse oximetry.

All of the colonoscopy procedures were performed by a single pediatric gastrointestinal endoscopist using an Olympus PCF-240L colonoscope (Olympus Corporation, Tokyo, Japan). In neonates or young infants, the Olympus GIF-Q230 gastroscope (Olympus Corporation, Tokyo, Japan) was used instead of a colonoscope. The examinations were performed in the left lateral position. The position of the patient was changed and manual compression of the abdomen was performed when there was difficulty in advancing the colonoscope. If a colorectal polyp was found, it was removed using the forceps or by polypectomy, and the specimen was sent for histologic studies.

3. Results

3.1. Demographic data and indications for examination

One hundred and ninety-two children with 201 colonoscopies and 27 rectosigmoidoscopies were enrolled. There were 81 girls and 111 boys, with a mean age of 7.7 ± 5.4 years (range, from 15 days to 18 years). Two or more sequential endoscopies were performed in 22 (11.5%) patients (Table 1), and 65% of the procedures involved conscious sedation. There were no major procedure-related complications in any of the patients. In the first colonoscopies of 169 patients, the cecum was successfully reached in 131 (77.5%) cases, while the terminal ileum was reached in 92 (54.4%) (Table 1). The most common indication for colonoscopy or sigmoidoscopy was LGIB (53.5%), followed by chronic abdominal pain (20.6%), IDA (11.8%), and chronic diarrhea (11.4%) (Table 2).

3.2. Conclusive diagnosis and diagnostic yield

Conclusive diagnosis relied on endoscopic imaging and/or histology and 144 patients (75%) had a conclusive diagnosis on their first examination, while 48 had negative findings. The most common conclusive diagnosis was nonspecific colitis (23.4%), followed by colorectal polyp (20.4%), lymphoid hyperplasia (6.3%), Crohn's disease (4.7%), ulcerative colitis (3.6%), and cow's milk protein allergy (3.6%).

The diagnostic yield was 77.3% in 110 patients with LGIB and colorectal polyp (26.4%) was the most commonly

Table 1 Demographic data of the patients undergoing colonoscopy.

	Patient no. (%)
Total numbers	228 (100)
Colonoscopy	201 (88.2)
Rectosigmoidoscopy	27 (11.8)
Sex	
Female:male	105 (46.1):123 (53.9)
Age (y)	
0—3	56 (24.6)
3—7	55 (24.1)
7—12	66 (28.9)
12—18	51 (22.4)
Examination times	
1	192 (84.2)
2	22 (9.7)
3	7 (3.1)
4	6 (2.6)
5	1 (0.4)
Depth (the 1st colonoscopy, $n = 169$)*	
Terminal ileum	92 (54.4)
Cecum	39 (23.1)
Colon	30 (17.8)
Rectum	8 (4.7)

* The number of the first colonoscopies excluded 23 first rectosigmoidoscopies.

encountered etiology, followed by nonspecific colitis (22.7%) and inflammatory bowel disease (IBD; 10.9%) (Table 2). Of the 47 patients with chronic abdominal pain, the diagnostic yield was 68.1%, with nonspecific colitis (25.5%) as the most common etiology. In 24 IDA patients, the diagnostic yield was 66.7% and most cases were IBD (25%) or cow's milk allergy (25%). Among the 24 patients with chronic diarrhea, the diagnostic yield was 79.2%, with IBD (29.2%) as the most common etiology.

3.3. Characteristics of colorectal polyps

The clinical and colonoscopic characteristics of 39 patients with colorectal polyps revealed a male predominance (2.2:1) and a mean age of 6.1 years (Table 3). Thirty-six (92.3%) of the 39 polyps were solitary, 36 were juvenile polyps, and three were tubular adenoma. The most common location of the polyp was the colon (53.8%) above the rectosigmoid portion, and 74.3% of patients presented with LGIB. All polyps were removed by forceps or polypectomy without significant bleeding or perforation.

4. Discussion

Except for data from the Pediatric Endoscopy Database System-Clinical Outcomes Research Initiative, the current report is the largest series of pediatric colonoscopy in the

Table 2 Indications for colonoscopy or sigmoidoscopy and the diagnostic yields.

Indications	Patient no. (%)*	Diagnostic yield	Patient no. (%)¶
Lower gastrointestinal bleeding	122 (53.5)	Polyp(s)	29 (26.4)
		Nonspecific colitis	25 (22.7)
		IBD	12 (10.9)
		Others†	19 (17.3)
		Negative	25 (22.7)
Chronic abdominal pain	47 (20.6)	Nonspecific colitis	12 (25.5)
		Polyp(s)	2 (4.3)
		Others‡	18 (38.3)
		Negative	15 (31.9)
Iron deficiency anemia	27 (11.8)	IBD	6 (25)
		Cow's milk allergy	6 (25)
		Others§	4 (16.7)
		Negative	8 (33.3)
Chronic diarrhea	26 (11.4)	IBD	7 (29.2)
		Nonspecific colitis	6 (25)
		Others‖	6 (25)
		Negative	5 (20.8)
Body weight loss	6 (2.6)	—	—
Recurrent intussusception	4 (1.8)	—	—
Follow-up treatment response	15 (6.6)	—	—
Others	10 (4.4)	—	—

* Some patients had two or more symptoms or signs.
† Anal fissure, angiodysplasia, cytomegalovirus (CMV) colitis, eosinophilic colitis, Henoch-Schönlein purpura (HSP), cow's milk allergy.
‡ Eosinophilic colitis, inflammatory bowel disease (IBD), lymphoma, tuberculosis, HSP.
§ Angiodysplasia, eosinophilic colitis, lymphoma.
‖ Eosinophilic colitis, pseudomembranous colitis, cow's milk allergy.
¶ There were 12 patients, three patients, and two patients with missing data in the lower gastrointestinal bleeding (LGIB), iron deficiency anemia (IDA), and chronic diarrhea groups, respectively, so we analyzed 110 patients with LGIB, 24 patients with IDA, and 24 patients with chronic diarrhea.

Table 3 Clinical characteristics of the patients with colorectal polyps ($n = 39$).

Characteristics	Patient no. (%)
Sex	
Female:male	12 (30.8):27 (69.2)
Age (y)	
Mean ± SD	6.1 ± 1.2
Polyps location	
Rectosigmoid	17 (43.6)
Colon	21 (53.8)
Ileocecal valve	1 (2.6)
Number of polyps	
Solitary	36 (92.3)
Multiple	3 (7.7)
Pathology	
Juvenile polyp	36 (92.3)
Tubular adenoma	3 (7.7)
Symptoms and signs	
Lower gastrointestinal bleeding	29 (74.3)
Recurrent intussusception	3 (7.7)
Prolapsed anal mass	3 (7.7)
Abdominal pain	2 (5.1)
Chronic diarrhea	1 (2.6)
Familial polyposis coli	1 (2.6)

literature in English.[6] Colonoscopy is performed less frequently in children than in adults because of difficulties in preparation and sedation, which are usually needed in children.[6] In the report by Hassall et al,[2] all 113 patients received colonoscopy under either general anesthesia or conscious sedation. By contrast, the present report shows only 65% of the procedures involving conscious sedation. This may be one of the reasons for the slightly lower success rate of reaching the cecum or terminal ileum (77.5%) in the present study compared to the series with full sedation (84—97.6%).[2,3,19] Another reason may be that while the pathologic lesions identified in other images were reached, the procedures were terminated in some patients before the endoscope reached the cecum. Although the terminal ileum approach is not necessary in each colonoscopy, previous study revealed that up to 85% of patients with Crohn's disease had a terminal ileum lesion, which was confirmed using colonoscopy and ileum biopsy.[20] Therefore, if IBD is suspected or there are no lesions in the colon, the ileum intubation is crucial in making a prompt diagnosis. As in other reports, there are no major procedure-related complications in the patients here.[3,7] Minor complications like cough with transient desaturation, intravenous fluid extravasation, and occasional slight oozing after polypectomy also occurred.

The most common indication for colonoscopy in this study is LGIB. Chronic abdominal pain, IDA, and chronic diarrhea are also common reasons for pediatric colonoscopy.[3—5,11] Moreover, this study highlights a new indication for evaluating the lead points of recurrent intussusception suspected from imaging studies. All (2 lymphomas and 2 polyps) were managed nonsurgically, with good outcomes.

According to the endoscopic features and histology, a conclusive diagnosis has been made in 75% of the patients. As in other reports from Asia, the two most common etiologies are nonspecific colitis (23.4%) and colorectal polyp (20.4%).[3,7,21] However, there is a lower rate (8.3%) of IBD in this study than that reported in The Netherlands.[14] Furthermore, 6.7% of 192 children with indications for colonoscopy have eosinophilic colitis (including cow's milk protein allergy).

The diagnostic yield of colonoscopy according to the major indications is 77.3% in LGIB, 68.1% in chronic abdominal pain, 66.7% in IDA, and 79.2% in chronic diarrhea. These results imply that LGIB (including colorectal polyps, nonspecific colitis, and IBD) and chronic diarrhea are alarming events for children who require further lower gastrointestinal investigations. The results also show more cases of colorectal polyps in children undergoing colonoscopy compared to those of a report from the United Kingdom (20.4% vs. 4.0%).[12] Among patients with chronic diarrhea, IBD is the leading etiology. El Mouzan et al[7] reported that pediatric patients with bloody diarrhea had a high colonoscopic yield (91%) compared to those with only chronic diarrhea (43%).[7] In the present study, only two patients with visible blood in their stools were categorized into the chronic diarrhea group. One was diagnosed as pseudomembranous colitis and the other eosinophilic colitis pathologically.

In contrast to colonoscopy in adults with unexplained IDA, which is highly recommended,[22] the role of diagnostic colonoscopy in children with IDA is uncertain. Esophagogastroduodenoscopy is generally applied in pediatric patients with unexplained IDA because it is associated with *Helicobacter pylori* infection.[23] However, in this study, *H. pylori* infection has been excluded in all of the patients with IDA prior to colonoscopy. The diagnostic yield of colonoscopy among these patients is 66.7%. This indicates that colonoscopy is an appropriate examination for evaluating children with unexplained IDA but without *H. pylori* infection, especially IBD and cow's milk protein allergy.

As in the current report, the reported prevalence of colon polyps in pediatric diagnostic colonoscopy in Asian populations (20.3—20.5%) is higher than that in Western populations (4.0—8.6%).[5,12,15,24] Most reports showed that 80—90% of polyps were located at the rectosigmoid colon.[3,5] However, in this study, only 43.6% of the polyps are at the rectosigmoid colon, which is similar to the report by Gupta et al.[24] Although most pediatric colon polyps are juvenile polyps, some are potentially premalignant.[25] This highlights the importance of colonoscopy rather than sigmoidoscopy for the diagnosis and treatment of pediatric colon polyps.

A colonic pathology is not uncommon in pediatric patients. Children presenting with symptoms or signs of lower gastrointestinal disorders should undergo colonoscopy to obtain a definite diagnosis and prompt treatment. Pediatric colonoscopy is a safe and effective procedure to detect pathologic lesions of the lower gastrointestinal tract.

Conflicts of interest

The authors have no conflicts of interest relevant to this article.

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