CME

Good Agreement Between Endoscopic Findings and Biopsy Reports Supports Limited Tissue Sampling During Pediatric Colonoscopy

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See "Value of Endoscopic Mucosal Biopsies in Normal-Appearing Colonic Mucosa" by Winter and Heyman on page 676.

ABSTRACT

Objectives: Colonoscopy in children routinely includes the practice of obtaining multiple biopsy samples even in the absence of gross mucosal abnormalities. The aim of our investigation was to examine the level of agreement between endoscopic and histological findings during pediatric colonoscopy. We also investigated the predictors of agreement and abnormal histology.

Methods: We performed an institutionally approved retrospective review of consecutive patients who underwent diagnostic colonoscopy during a 6-month period. Descriptive analyses and regression models were used to determine agreement rates, as well as potential predictors of both agreement and abnormal histology.

Results: Of 390 included colonoscopies, endoscopists (n = 26) reported abnormal gross findings in 218 (56%) and pathologists (n = 4) found histopathology in 195 (50%). Considering histology as the criterion standard, endoscopy had a sensitivity of 90% and a specificity of 78%. Reports of grossly normal endoscopic findings were highly associated with agreement (odds ratio [OR] 1.9, $P = 0.001$). A known diagnosis of inflammatory bowel disease was a strong predictor of abnormal histology (OR 6.4, $P < 0.0001$). Abdominal pain as a procedural indication was a strong predictor for normal histology (OR 0.4, $P < 0.0001$).

Conclusions: The results of our study suggest good agreement between endoscopic and histological findings, especially when an endoscopist reports normal-appearing colonic mucosa. We identified predictors of abnormal histology to include known inflammatory bowel disease, whereas abdominal pain was found to be a negative predictor. Future studies are needed to determine evidence-based protocols for obtaining biopsies during colonoscopy in children.

Received December 13, 2013; accepted January 16, 2014.

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The authors report no conflicts of interest.

DOI: 10.1097/MPG.0000000000000317

Key Words: biopsy, biopsy agreement, colonoscopy, indications for endoscopy, pediatric

(*JPGN* 2014;58: 773–778)

For the past 40 years, it has been standard practice to obtain tissue biopsies during pediatric colonoscopy, even in the absence of gross mucosal abnormalities. Tissue sampling of normal-appearing mucosa has been recommended in several national position statements because of pervasive concerns that clinically valuable information may be gained from nonfocal colonic biopsies in children (1,2). A close look at the literature, however, reveals that these practice guidelines are not evidence based and discount major advances in endoscopic technology and clinical expertise. In turn, this biopsy practice may contribute to overuse of pathology services and excess procedural costs associated with pediatric colonoscopy (3).

The North American Society for Pediatric Gastroenterology, Hepatology, and Nutrition (NASPGHAN) has recently made an attempt at standardizing biopsy practice specifically for children with inflammatory bowel disease (IBD) (1). These guidelines are based on expert opinion and consensus, and cite a paucity of literature on the subject. Similarly, a Standards of Practice document published by the American Society of Gastrointestinal Endoscopy has supported nonfocal tissue sampling during all esophagogastroduodenoscopy and colonoscopy in children (2). This statement surmises that biopsies should commonly be obtained because of an inability to adequately assess differences between normal and abnormal mucosa in children by using endoscopy alone; however, it is supported only by a single study examining gross and histological appearance of duodenal tissue in a relatively small number of patients (4).

Given improvements in endoscopic imaging technology during the past decade, the aim of our study was to assess the present level of agreement between endoscopic and microscopic findings in pediatric colonoscopy performed at our institution. Our study hypothesis was that colonic mucosa that appeared normal to endoscopists would not be associated with clinically significant pathology. We also examined the predictors of agreement between endoscopists and pathologists, as well as the predictors of pathological findings, including patient medical history and procedural indications, in an effort to risk-stratify patients who may be candidates for specific biopsy strategies.

METHODS

We performed a retrospective chart review with institutional review board approval (Boston Children's Hospital Committee on Clinical Investigation Protocol #P00002470) of consecutive patients who underwent diagnostic colonoscopy (defined as an endoscope advanced from the rectum to beyond the splenic flexure) with biopsies, between June 1, 2010, and December 31, 2010, at Boston Children's Hospital, Boston, MA. Patients were excluded

from the study if they had a history of colectomy, if the primary indication for the procedure was for colonic motility testing, if no biopsies were taken proximal to the splenic flexure, and if the procedure was performed with the a priori intention to limit investigation of the mucosa to the rectum and/or the sigmoid colon.

Our primary outcome was an agreement between endoscopic and histological findings. We define agreement as either endoscopist-reported normal mucosa and pathologist-reported normal histology, or endoscopist-reported abnormal mucosa and pathologist-reported abnormal histological findings. Secondary outcomes included factors predicting the agreement, as well as the predictors of abnormal histological findings. We defined provider experience by time elapsed since the provider completed their fellowship (fellowship completed <5 years before the colonoscopy, 5–10 years prior, >10 years prior). Endoscopy procedure notes were examined to determine whether fellow trainees were present at the time of the procedure (yes/no), as well as time of day of the procedure (AM [12:00 AM–11:59 AM] vs PM [12:00 PM–11:59 PM]), and patient weight (<10 kg, 10–20 kg, >20 kg). In addition, indications for the procedure were reviewed and dichotomized as the presence or absence of abdominal pain, weight loss, blood in stool, diarrhea, poor growth, and history of IBD. Other indications for procedures included personal or family history of polyps and an evaluation for graft-versus-host disease.

Gross endoscopic findings were categorized as being consistent with inflammation, erosive changes, and other findings (including polyps and stenosis). Histological findings were characterized as acute inflammation, chronic inflammation, and other findings (which included polyps, increased eosinophils, and abnormal apoptosis).

Data Analysis

Descriptive statistical analyses were conducted summarizing the characteristics of the patient population undergoing colonoscopy, as well as the clinicians who performed the endoscopic procedures and pathological analysis. Agreement rate is expressed as proportion of procedures that had an agreement between gross endoscopic appearance and histological findings. Considering pathological findings as criterion standard, sensitivity and specificity were used to describe how gross findings were associated with pathological findings.

We used generalized linear models with logit link to explore factors (patient or provider characteristics) for the agreement rates between endoscopists and pathologists, as well as for predictors of positive pathological findings. To accommodate for potential dependence among procedures performed by the same provider, we used the generalized estimation equation approach to estimate the model parameters. Univariate regression models were fitted on all potential risk factors individually. Any risk factor that had a $P \leq 0.2$ in the univariate regression model was included as a candidate variable in the multivariate regression model. The final multivariate regression model only included variables with $P \leq 0.05$.

RESULTS

A total of 524 colonoscopies in consecutive unique patients were performed during the study period at Boston Children's Hospital. Of these, 390 met our inclusion criteria and were analyzed. Table 1 lists the characteristics of patients and procedures included in the study. A total of 134 cases were excluded for the following reasons: 40 had postsurgical anatomy, 38 were performed for dysplasia screening, 33 were performed for motility testing, and 23 involved examination to the splenic flexure.

TABLE 1. Characteristics of patients and procedures included in the analysis

Characteristics of patients (N = 390)	
Patient weight, n (%)	
<10 kg	5 (1)
10–20 kg	47 (12)
>20 kg	338 (87)
Indications, n (%)	
Abdominal pain	145 (37)
Known diagnosis of IBD	104 (27)
Weight loss	47 (12)
Poor growth	10 (3)
Diarrhea	132 (34)
Blood in stool	127 (33)
Other indication*	112 (29)
Characteristics of procedures (N = 390)	
Fellow present, n (%)	147 (38)
Performed in the morning (AM), n (%)	280 (72)
Endoscopist experience, n (%)†	
<5 y	38 (10)
5–10	150 (38)
>10 y	202 (52)
Pathologist experience, n (%)‡	
>5 y	357 (92)

IBD = inflammatory bowel disease.
* Other indications for procedures included personal or family history of polyps, and evaluation of graft-versus-host disease.
† Total number of endoscopists was 26.
‡ Total number of pathologists was 4.

Each procedure was staffed by 1 of 26 endoscopists. Overall, 52% of procedures were performed by endoscopists with >10 years of experience (Table 1). A total of 4 pathologists were involved in examining biopsy samples. Of the 390 procedures that met the inclusion criteria, a total of 218 (56%) were documented in the procedure note as having abnormal mucosal findings (Table 2), and 195 (50%) were noted in pathology reports to have abnormal histology (Table 2).

Agreement

Interprovider agreement between endoscopic and pathological findings is shown in Table 3. The total interprovider agreement

TABLE 2. Summary of endoscopic and pathological findings

Endoscopic findings (N = 390)	
Normal, n (%)	172 (44)
Abnormal, n (%)	218 (56)
Inflammation, n (%)	163 (75)†
Erosive changes, n (%)	106 (49)†
Other endoscopic findings*, n (%)	130 (60)†
Pathological findings (N = 390)	
Normal, n (%)	195 (50)
Abnormal, n (%)	195 (50)
Acute inflammation, n (%)	154 (79)§
Chronic inflammation, n (%)	119 (61)§
Other pathological findings‡, n (%)	76 (39)§

* Other endoscopic findings included polyps and stenosis.
† Percentages based on endoscopy abnormal findings, n = 218.
‡ Other pathological findings included polyps, increased eosinophils, and abnormal apoptosis.
§ Percentages based on pathology abnormal findings, n = 195.

TABLE 3. Agreement between endoscopist and pathologist regarding procedural findings

		Pathologist findings	
		+	−
Endoscopist findings (%)	+	175 (45)	43 (11)
	−	20 (5)	152 (39)

rate between endoscopists and pathologists was 84%. The total disagreement rate was 16%, with a majority of the disagreement being when the endoscopist reported an abnormal finding whereas the pathologist reported that the biopsies obtained were normal (11%). If histology was considered as the criterion standard, endoscopy was found to have a sensitivity of 90% and a specificity of 78%.

In 20 patients there was an evidence of abnormal histology in reportedly normal-appearing colonic mucosa. The details of these patients are listed in Table 4. Eight of the 20 patients had a known diagnosis of IBD, 4 had symptoms highly suspicious for IBD, and another 3 patients were immunosuppressed secondary to either bone marrow transplant or nephrotic syndrome. Three of the 20 patients had histological findings of unknown clinical significance: 2 patients had focally increased eosinophils in the lamina propria in a few but not all of the biopsies obtained. The remaining patient had a single crypt abscess with normal epithelial architecture in 1 specimen and rare intraepithelial neutrophils in another specimen. Of the 2 other patients with normal-appearing mucosa, one had histological findings consistent with proctitis and the other had lymphocytic colitis.

Predictors of Agreement

We examined predictors of agreement between endoscopist reported findings and pathologist reported findings (Table 5). Univariate regression analyses showed that abnormal histology was significantly associated with a higher agreement with endoscopic reports with an odds ratio (OR) of 2.4 ($P = 0.005$). Agreement rates

TABLE 4. List of the 20 patients with evidence of abnormal histology in reportedly normal appearing colonic mucosa

Patient	Indication for colonoscopy	Pertinent medical history and laboratory reports	Histological findings
1	Recurrent aphthous stomatitis	Personal history of Crohn disease	Mildly active ileitis
2	Recurrent perirectal abscess	Elevated ESR and CRP	Chronic inactive ileitis; chronic inactive colitis in the cecum
3	Hematochezia, weight loss	None	Focally increased lamina propria eosinophils in the transverse colon
4	Diarrhea	Elevated ESR and CRP	Mildly active colitis in the transverse colon
5	Perianal abscess	Elevated ESR and CRP	Mildly active ileitis with non-necrotizing granulomas in the transverse colon
6	Abdominal pain	Personal history of Crohn disease	Paneth cell metaplasia in the left colon
7	Crohn disease follow-up colonoscopy	Personal history of Crohn disease	Increased intraepithelial eosinophils in the descending colon
8	Anemia, heme positive stool	*Helicobacter pylori* positive	Rare intraepithelial neutrophils in the descending colon; single crypt abscess in the sigmoid colon
9	Diarrhea	Personal history of Crohn disease	Focal acute inflammation and non-necrotizing granulomas in the sigmoid colon
10	Abdominal pain, perianal abscess	Elevated ESR and CRP	Multiple non-necrotizing granulomas in the TI, descending and sigmoid colon
11	Diarrhea, abdominal pain	None	Increased eosinophils in the lamina propria; occasional intraepithelial eosinophils throughout colon
12	Crohn disease follow-up colonoscopy	Personal history of Crohn disease	Focal mildly active colitis in the cecum; focally increased eosinophils in the lamina propria in the descending colon
13	Diarrhea, abdominal pain	Personal history of Crohn disease	Mildly active ileitis and pancolitis
14	Diarrhea, abdominal pain	Nephrotic syndrome, elevated ESR, CRP, and hypoalbuminemia	Mildly active ileitis; focal neutrophilic cryptitis; mild active colitis in the descending colon
15	Hematochezia	Personal history of ulcerative colitis	Chronic moderately active colitis in the rectum
16	Diarrhea, abdominal pain, hematochezia	Personal history of ulcerative colitis	Mildly active colitis in the transverse colon; chronic mildly active colitis in the descending colon, sigmoid, and rectum
17	Diarrhea, hematochezia	Personal history of HSCT	Basal epithelial apoptosis in the TI, descending colon, and rectum
18	Diarrhea	None	Increased intraepithelial lymphocytes throughout the entire colon
19	Diarrhea, weight loss, anemia	None	Mildly active colitis in the rectum
20	Diarrhea and weight loss	Personal history of HSCT	Rare basal crypt epithelial apoptosis in the TI and colon

CRP = C-reactive protein; ESR = erythrocyte sedimentation rate; HSCT = hematopoietic stem cell transplant; TI = terminal ileum.

TABLE 5. Prediction models of agreement between endoscopists and pathologists

Predictors of agreement	Agreement rate among patients with or without predictors, n (%)		OR	95% CI	*P*
	Predictor status = yes	Predictor status = no			
Univariate predictors					
Patient indications					
Abdominal pain	124/145 (86)	203/245 (83)	1.3	0.8–2.0	0.4
Known diagnosis of IBD	85/104 (82)	242/286 (85)	0.8	0.4–1.6	0.6
Weight ≤20 kg	41/52 (79)	286/338(85)	0.7	0.3–1.3	0.2
Poor growth	7/10 (70)	320/380 (84)	0.4	0.1–1.8	0.2
Weight loss	42/47 (89)	285/343 (83)	1.8	0.7–4.5	0.2
Diarrhea	113/132 (86)	214/258 (83)	1.2	0.7–2.3	0.5
Blood in stool	112/127 (88)	215/263 (82)	1.6	0.9–3.0	0.09
Blood in stool plus diarrhea	26/28 (93)	301/362 (83)	2.6	0.8–8.2	0.10
Blood in stool plus diarrhea or weight loss	30/33 (91)	297/357 (83)	2.0	0.6–6.6	0.2
Gross findings					
Normal gross findings	152/172 (88)	175/218 (80)	1.9	1.3–2.8	0.001
Inflammation	130/163 (80)	197/227 (87)	0.6	0.3–1.0	0.06
Erosive changes	94/106 (89)	233/284 (82)	1.7	1.0–2.8	0.04
Other*	113/130 (87)	214/260 (82)	1.4	0.9–2.3	0.12
Histological findings					
Abnormal findings	175/195 (90)	152/195 (78)	2.4	1.3–4.5	0.005
Acute inflammation	144/154 (94)	183/236 (78)	4.0	1.8–8.6	0.0004
Chronic inflammation	114/119 (96)	213/271 (79)	6.0	2.8–12.6	<0.0001
Other†	65/76 (85.5)	262/314 (83)	1.1	0.7–1.9	0.6
Procedure characteristics					
Endoscopist experience					
>10 y	173/202 (86)	154/188 (82)	1.3	0.7–2.5	0.3
>5 y	294/352 (83.5)	33/38 (87)	0.7	0.3–1.6	0.5
Fellow present	119/147 (81)	208/243 (86)	0.7	0.4–1.2	0.2
AM procedure	235/280 (84)	92/110 (84)	1.0	0.6–1.5	0.9
Pathologist experience					
>5 y	297/357 (83)	30 /33(91)	0.5	0.2–1.3	0.2
Multivariate predictors					
Normal gross findings			3.2	1.9–5.2	<0.0001
Erosive changes			3.3	1.7–6.1	0.0002
Blood in stool			1.9	1.0–3.6	0.05

CI = confidence interval; IBD = inflammatory bowel disease; OR = odds ratio.
* Other gross findings included polyps and stenosis.
† Other histological findings included polyps, apoptosis and increased eosinophils.

were high when there was acute inflammation or chronic inflammation on histology. Reports of grossly normal endoscopic findings were similarly associated with a higher agreement rate (OR 1.9, $P = 0.001$). Gross endoscopic observations of inflammation and erosive changes were marginal predictors of higher agreement ($P < 0.06$). Patient indications of blood in stool ($P = 0.09$) and blood in stool associated with diarrhea ($P = 0.10$) were associated with good agreement. The agreement was not associated with other candidate predictor variables, including endoscopist and pathologist experience, trainee presence, and procedure time of day.

Multivariate regression modeling identified that normal gross findings on endoscopy (OR 3.2, 95% confidence interval [CI] 1.9–5.2, $P < 0.0001$), endoscopic observation of erosive changes (OR 3.3, 95% CI 1.7–6.1, $P = 0.0002$), and the procedure indication of blood in stool (OR 1.9, 95% CI 1.0–3.6, $P = 0.05$) were independent predictors of higher agreement (Table 5).

Predictors of Abnormal Histological Findings

Univariate regression analyses showed that all positive endoscopic findings were statistically significant predictors of abnormal histological findings ($P < 0.0001$, Table 6). With respect to procedural indications, we found that having a known diagnosis of IBD was a highly significant predictor of abnormal histological findings (OR 6.4; $P < 0.0001$). In addition, the symptom constellation of blood in stool and either weight loss or diarrhea was a significant predictor of abnormal histological findings (OR 3.4, $P = 0.001$).

Abdominal pain as a sole indication for performing colonoscopy was a highly significant predictor of normal biopsy findings (OR 0.4, $P < 0.0001$). Multivariate regression modeling identified that all the above-mentioned variables remained independent significant predictors of abnormal histological findings (Table 6).

DISCUSSION

The aim of our study was to assess the level of agreement between endoscopist and pathologist reports of findings in children undergoing diagnostic colonoscopy with biopsies. Our results show overall good agreement between endoscopists and pathologists. Although endoscopists and pathologists were found to disagree in 16% of all cases, the majority of disagreement occurred when an

TABLE 6. Procedural indications and gross findings as predictors of abnormal histological findings

Predictors of pathological findings	Pathological findings, n (%)		OR	95% CI	*P*
	Predictor status = yes	Predictor status = no			
Univariate predictors					
Patient indications					
Abdominal pain	51/145 (35)	144/245 (59)	0.4	0.3–0.5	<0.0001
Known diagnosis of IBD	83/104 (80)	112/286 (39)	6.4	3.9–10.6	<0.0001
Weight ≤20 kg	22/52 (42)	173/338 (51)	0.70	0.4–1.3	0.25
Poor growth	7/10 (70)	188/380 (49)	2.4	0.5–11.1	0.25
Weight loss	24/47 (51)	171/343 (50)	1.0	0.5–2.0	0.9
Diarrhea	63/132 (48)	132/258 (51)	0.9	0.6–1.3	0.5
Blood in stool	67/127 (53)	128/263 (49)	1.2	0.7–2.0	0.6
Blood in stool plus diarrhea	21/28 (75)	174/362 (48)	3.2	1.3–8.1	0.01
Blood in stool plus diarrhea or weight loss	25/33 (76)	170/357 (47)	3.4	1.65–7.2	0.001
Gross findings					
Inflammation	130/163 (80)	65/227 (29)	9.8	5.3–18.4	<0.0001
Erosive changes	94/106 (89)	101/284 (36)	14.6	7.9–27.0	<0.0001
Other*	113/130 (87)	82/260 (32)	14.9	8.1–27.4	<0.0001
Multivariate predictors					
Endoscopic reports					
Gross inflammation			3.5	1.8–6.7	0.0002
Erosive changes			7.2	3.5–15.1	<0.0001
Other gross findings*			8.2	3.2–20.7	<0.0001
Patient indications					
Abdominal pain			0.4	0.2–0.6	<0.0001
IBD			2.8	1.4–5.9	0.0055
Blood in stool plus weight loss or diarrhea			3.2	1.6–6.2	0.0008

CI = confidence interval; IBD = inflammatory bowel disease; OR = odds ratio.
* Other gross findings included polyps and stenosis.

endoscopist questioned the evidence of mucosal findings, but in fact tissue samples showed normal histology. Endoscopist reports of grossly normal mucosa were a strong predictor of agreement. Our data suggest that pediatric endoscopists are good at diagnosing normal colon based on its appearance, and if anything, err on the side of overcalling a mucosal appearance as abnormal. In turn, obtaining many biopsies as standard practice from normal-appearing colons may not be necessary in children.

Our study also suggests that it may be possible to develop evidence-based biopsy protocols based on patient risk factors and procedural indications. A direct look at the 20 cases in our study wherein histopathology was detected in reportedly normal-appearing colonic mucosa revealed that a majority had either a prior diagnosis of IBD or symptoms and laboratory findings highly suspicious for IBD. Another 3 patents in this group were symptomatic with diarrhea and were also immunocompromised. Although we agree it is likely to remain appropriate to obtain a prudent number of biopsies from children with normal-appearing mucosa, we believe our data support the use of a combination of endoscopic appearance and evidence-based risk stratification to develop protocols that can reduce the number of biopsies obtained without affecting the ability to make a correct diagnosis. Such protocols have the potential to significantly decrease costs of performing pediatric colonoscopy (3).

At our large tertiary care institution, it is common practice for our faculty to obtain multiple nonfocal biopsies at multiple colonic segments, even during colonoscopies that appear to have normal colonic mucosa throughout. The rationale behind this practice is the belief that pathology may be missed if biopsies are not obtained. The findings of our study support those of Badizadegan and Thompson (3), who recently reported that present strategies of taking multiple biopsy specimens during pediatric colonoscopies added little to no benefit compared with strategies taking less biopsies. Our data support a call by Badizadegan and Thompson for the development of new biopsy strategies in pediatric colonoscopy.

We believe our study supports the NASPGHAN recommendation to obtain tissue samples during colonoscopy in patients with known IBD, regardless of the presence or absence of mucosal findings (1). The guideline also suggests it may be appropriate to routinely sample normal-appearing mucosa if specific symptoms and laboratory tests are highly suggestive of IBD. Our findings support those of Heyman et al (5), who reported 5 patients with a high clinical suspicion for IBD and normal-appearing colonoscopy. In this case series, all of the patients had an evidence of colitis on histology. Larger studies of diagnostic yield from children with known and suspected diagnoses of IBD may be necessary to further refine strategies and indications for obtaining biopsies in this population.

In contrast, the symptom of abdominal pain as a primary indication for performing the procedure was an extremely strong negative predictor of histopathology. NASPGHAN guidelines have long held that abdominal pain is not an appropriate sole indication for pediatric colonoscopy (6). Despite 1 recently published study that suggests endoscopy may provide diagnostic benefit in children with chronic abdominal pain, our findings suggest an extremely low diagnostic yield from colonoscopic biopsies for this procedural indication in otherwise healthy children (7).

There is a paucity of literature on the subject of endoscopy and histology agreement. The majority of what has been published concerns adult patients with chronic unexplained diarrhea, wherein the question of whether to obtain mucosal biopsies in such patients

with normal-appearing colons remains a topic for debate (8–13). Proponents of tissue sampling have suggested that there is a risk of missing specific diagnoses, including collagenous and lymphocytic colitis (8,10–12). Da Silva et al (8) reviewed 162 patients with chronic diarrhea and normal endoscopic appearance of the colon, and found 32% had histological findings in grossly normal-appearing colons. The majority of these patients had collagenous and lymphocytic colitis. Others would argue that the low frequency of these diseases renders this strategy not cost-effective (9). We believe this actuality may hold even more true in pediatrics owing to the extreme rarity of these 2 diagnoses in children.

Our study has a number of limitations. It was retrospective and exploratory in nature. It represents experience from a single institution, and may lack generalizability to other centers both in the United States and across the world. Other limitations include variability in endoscopic terms used to describe pathology that we found in procedure notes, which could affect the accuracy of data. For our study purposes, we defined endoscopist experience by years in practice, and not by clinical volume, which presumably also impacts experience. Finally, our study was not powered to investigate best protocols for obtaining biopsies and, therefore, we are not prepared to make practice recommendations at this time. Nevertheless, our results are provocative, because they call into question standard practices that may lead to overuse of pathology services and contribute to high costs of colonoscopy in children.

Our study represents the largest pediatric study to date—in terms of numbers of procedures, endoscopists, and pathologists—to examine agreement between endoscopic and histological findings in pediatric colonoscopy. The results of our study suggest a good agreement between endoscopic and histological findings, especially when an endoscopist reports colon tissue to appear normal. In addition, we identified predictors of abnormal histology to include both known IBD and the combination of weight loss, diarrhea, and blood in stool. Abdominal pain was found to be a negative predictor of histopathology. Future studies are needed to determine an evidence basis for biopsy strategies during colonoscopy in children.

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