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ORIGINAL ARTICLE

Quality indicators in pediatric colonoscopy

Indicadores de calidad en colonoscopía pediátrica

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What do we know about the subject matter of this study?

An international consensus on quality indicators and standards in pediatric endoscopy and colonoscopy was recently published. The minimum requirements for ileal (≥ 85%) and cecal (≥ 90%) intubation rates define a high-quality ileocolonoscopy.

What does this study contribute to what is already known?

This is the first Latin American study to evaluate quality indicators in pediatric colonoscopy. Adequate anesthesia and bowel preparation are the main indicators that favor ileal intubation.

Abstract

Objectives: An ileal intubation rate ≥ 85% is one of the most important quality indicators in pediatric colonoscopy, particularly due to screening for inflammatory bowel disease. The primary objective of this study was to determine the ileal intubation rate. Secondary objectives included assessing other quality indicators, such as bowel preparation, type of sedation, and use of general anesthesia. **Patients and Methods:** Observational, descriptive, cross-sectional study. All colonoscopies performed at two pediatric hospitals in Santiago, Chile, between September 2020 and November 2022 were included. Colonoscopies without the intention of ileal intubation were excluded. The following were evaluated: sociodemographic characteristics, procedure indication, type of sedation, bowel preparation regimen, Boston Bowel Preparation Scale score, endoscopist's experience, whether a pediatric gastroenterology trainee was present during the procedure, ileal and cecal intubation rates, reasons for incomplete procedures, and complications. **Results:** A total of 99 colonoscopies performed at two pediatric hospitals in Santiago, Chile, were included. Of the patients, 47.5% were male, with a median age of 12 years. Sedation was used in 51% of procedures,

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while 49% were performed under general anesthesia. Sodium picosulfate was the most frequently used bowel preparation agent (82.8%). The main indications for colonoscopy were rectal bleeding and suspected or follow-up of inflammatory bowel disease. The overall ileal intubation rate was 60.6%; stratified by intervention type, it was 45.8% with sedation and 82.5% with general anesthesia. In multivariate analysis, a Boston scale score ≥ 6 (OR: 5.6) and the use of general anesthesia (OR: 11.7) were significantly associated with a higher likelihood of ileal intubation. **Conclusions:** Our findings suggest that optimizing bowel preparation and the use of general anesthesia can significantly improve ileal intubation rates, contributing to compliance with international quality standards and more efficient use of hospital resources.

Introduction

Colonoscopy is used for the diagnosis and treatment of gastrointestinal diseases in adults and children. In adults, it is mainly used for colorectal cancer screening and adenoma detection. In pediatrics, the main indications are the study of abdominal pain and lower gastrointestinal bleeding[1,2].

A high-quality colonoscopy is defined as a procedure performed with an appropriate clinical indication, allowing for the confirmation or exclusion of a diagnosis, the implementation of appropriate therapy, and the minimization of associated risks[1,3]. Recently, the North American Society and the European Society for Pediatric Gastroenterology, Hepatology, and Nutrition (NASPGHAN and ESPGHAN) joined forces in the international Pediatric Endoscopy Quality Improvement Network (PEnQuIN) to establish quality standards and indicators[4]. These guidelines indicate that ileal intubation is one of the most important markers in pediatrics, as it is essential for investigating inflammatory bowel disease (IBD), and is therefore used as an indicator of complete colonoscopy. In addition, they recommend ileal intubation rates ≥ 85%, cecal intubation rates ≥ 90%, and adequate bowel preparation ≥ 80% of colonoscopies.

Ileal intubation rates range from 51% to 100% in published international studies[1,2,6-10]. This depends on adequate bowel preparation, good sedation or anesthesia, and the experience of the endoscopist[1,2,4,5]. There is no information on quality indicators in pediatric colonoscopy in Chile or Latin America, except for one study on different bowel preparations[11].

The main objective of this study is to determine the ileal intubation rate (IIR) in colonoscopies of pediatric patients; the secondary objectives are to evaluate other quality indicators, such as the type of bowel preparation, the location where the procedure is performed, and the type of sedation or anesthesia used, among others.

Patients and Method

Design

Observational, descriptive, cross-sectional study. All colonoscopies performed at the *Hospital Dr. Exequiel González Cortés* (HEGC) and the *Hospital de Niños Dr. Roberto del Río* (HRRio) between September 2020 and November 2022 were included. Colonoscopies without the intention of ileal intubation were excluded.

At both centers, all colonoscopies were performed by seven pediatric gastroenterologists. When the procedure was performed under sedation, it was administered either by the operators themselves (using midazolam and/or fentanyl) or by a pediatric intensivist (using midazolam, fentanyl, and/or propofol). When the procedure was performed under general anesthesia, it was administered by an anesthesiologist.

All bowel preparations were prescribed by the treating gastroenterologists, according to each hospital's protocol.

Data collection

Using a pre-established form, the following were recorded: sociodemographic characteristics, indication for the procedure, type of sedation, type of bowel preparation, bowel preparation score according to the Boston scale, endoscopist experience, whether a pediatric gastroenterology trainee was present during the procedure, ileal and cecal intubation, reason for incomplete procedure, and complications. The Boston bowel preparation scale has a score of 0 to 9 points, with a score of ≥ 6 being considered adequate preparation. The endoscopist's experience was based on the years of subspecialty practice, as the exact number of annual procedures performed by each endoscopist was not clearly available.

Statistical analysis

Descriptive statistics were used to characterize the sample. Relative frequency and percentage for the categorical variables, and mean, standard deviation,

median, and range for the continuous ones. The chi-square test was used to evaluate the association of categorical variables, and the t-test was used to evaluate the difference between means. A multivariable logistic regression model was used to identify the predictor variables for ileal intubation, such as type of sedation, endoscopist experience, Boston scale score, and presence of a pediatric gastroenterology trainee during the procedure. In all tests, a p-value < 0.05 was considered statistically significant. All statistical analyses were performed using R 4.3.2 software.

Ethical considerations

The study was approved by the Ethics Committee of each participating hospital, as well as by the Southern Metropolitan Health Services (SSMS) and Northern Metropolitan Health Services (SSMN), which are the regional health authorities of the Chilean health system. The SSMS Ethics Committee and the SSMN approved the study through Resolution No. 72-24082020. The legal guardian of each patient included in the study signed a written informed consent.

Results

A total of 99 colonoscopies were analyzed. 47.5% of the children undergoing colonoscopy were male. The median age was 12 years (range 2-19). 51% of colonoscopies were performed under sedation and 49% under general anesthesia. The most used bowel preparation was sodium picosulfate (82.8%), followed by polyethylene glycol (PEG) with electrolytes or combinations of sodium picosulfate and sodium phosphate (Phospho-soda) enemas with PEG. Adequate bowel preparation was achieved in more than half of the subjects undergoing the procedure (58.6%). The average number of years of experience of the endoscopists was 8.04 (SD 4.32) years. A pediatric gastroenterology trainee was present in 63.6% of the procedures (Table 1). The main indications for colonoscopy were rectal bleeding (33.3%), suspected IBD (19.2%), and monitoring of patients with ulcerative colitis (18.2%) (Figure 1).

The IIR was 60.6%, with procedures performed under sedation and general anesthesia accounting for 45.8% and 82.5%, respectively. Table 2 shows the variables related to the success of ileal intubation. The experience of the endoscopist and the presence of a pediatric gastroenterology trainee during the procedure showed no relationship with the IIR. In addition, the type of sedation and the Boston scale score were variables that showed a statistically significant association ($p < 0.001$ and $p = 0.003$, respectively). In the multivariate analysis, a Boston scale score ≥ 6 (OR 5.6; 95% CI 1.9-17.6; $p = 0.002$) and the use of general anesthesia (OR 11.7; 95% CI 3.4-49.3; $p = 0.000$) were associated with a higher probability of ileal intubation. The variables of endoscopist experience (OR 0.9; 95% CI 0.8-1.02; $p = 1.36$) and presence of a pediatric gastroenterology trainee (OR 0.3; 95% CI 0.1-1.2; $p = 0.117$) were not statistically significant.

Table 1. Characteristics of patients and colonoscopies

	n = 99
Age, years	
Mean (SD)	10.4 (4.40)
Median [Min – Max]	12 [2 – 19]
Sex, n (%)	
Female	52 (52.5%)
Male	47 (47.5%)
Procedure location, n (%)	
Procedure room	71 (71.7%)
Operating room	28 (28.3%)
Type of sedation, n (%)	
General anesthesia	40 (40.4%)
Sedation	59 (59.6%)
Boston Bowel Preparation Scale, n (%)	
Less than 6	34 (34.3%)
Equal to or greater than 6	58 (58.6%)
No information	7 (7.1%)
Endoscopist experience, years	
Mean (SD)	8.04 (4.32)
Median [Min – Max]	6 [1 – 16]
Presence of pediatric gastroenterology trainee, n (%)	
No	36 (36.4%)
Yes	63 (63.6%)
Ileal intubation, n (%)	
No	39 (39.4%)
Yes	60 (60.6%)
Cecal intubation, n (%)	
No	15 (15.2%)
Yes	84 (84.8%)

The cecal intubation rate was 84.8%, with no statistically significant difference when comparing the sedation and general anesthesia groups.

The main causes of incomplete procedures were technical difficulty and inadequate bowel preparation. As a result, the Boston scale score could not be calculated in 7 procedures (7.1%) due to incomplete colonoscopy. Gastroenterologists reported that technical difficulties were mainly caused by insufficient sedation, significant pain during the procedure, or difficulty in advancing the colonoscope. Two sedation- or medication-related complications were recorded: one case of rash and one case of transient hypertension.

Table 2. Factors affecting ileal intubation

	No ileal intubation n = 39 (%)	Ileal intubation n = 60 (%)	p-value
Type of sedation, n (%)			
General anesthesia	7 (17.9%)	33 (55.0%)	< 0.001
Sedation	32 (82.1%)	27 (45.0%)	
Endoscopist experience, years			
Mean (SD)	8.97 (4.93)	7.43 (3.79)	0.102
Median [Min – Max]	6 [1 – 16]	5 [1 – 15]	
Boston Bowel Preparation Scale, n (%)			
Lesser than 6	19 (48.7%)	15 (25.0%)	0.00247
Equal to or greater than 6	13 (33.3%)	45 (75.0%)	
Presence of pediatric gastroenterology trainee, n (%)			
No	13 (33.3%)	23 (38.3%)	0.771
Yes	26 (66.7%)	37 (61.7%)	

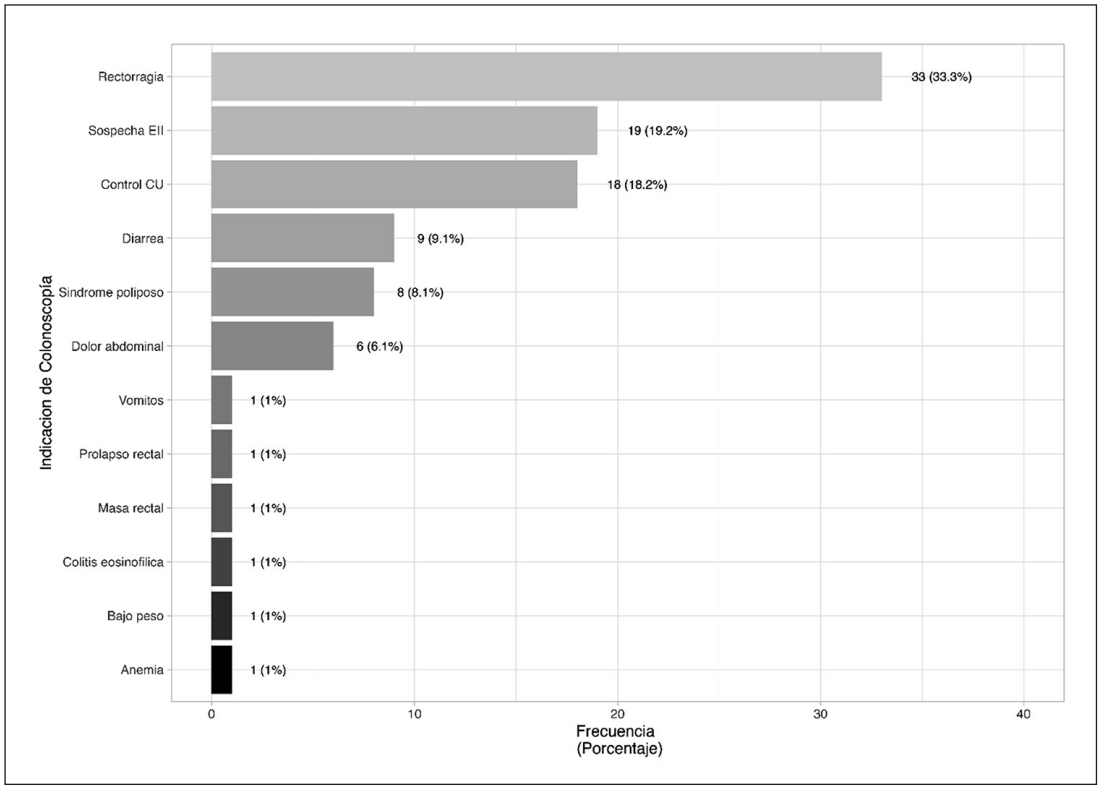

Figure 1. Indications for colonoscopy in pediatric patients.

Discussion

In our study, the indications for colonoscopy in pediatric patients were similar to those previously reported in the literature, with IBD, rectal bleeding, chronic diarrhea, and abdominal pain being the most frequent causes.

The IIR and cecal intubation rate achieved in our study were 60.5% and 84.8%, respectively. These results are comparable to those reported by Thakkar et al.[2], who described an IIR of 69.4% and a cecal intubation rate of 85% in a multicenter cohort of pediatric hospitals in the United States. Similarly, Wu et al.[9] reported an IIR of 54.4% and a cecal intubation rate

of 77.5% in their series of 169 procedures. However, other studies, such as that by Singh et al.[5] in Australia, have reported significantly higher rates, with an IIR of 92.4% and a cecal intubation rate of 96.3%.

A relevant finding was the significant difference observed in IIR between procedures performed under general anesthesia and those under sedation, with rates of 82.5% and 45.8%, respectively. This suggests that the type of sedation is an important factor for the success of the procedure and could lead to a rethinking of the need for anesthesiologists and operating rooms to improve outcomes in pediatric colonoscopies. In fact, most studies reporting higher IIR rates correspond to procedures performed under general anesthesia[5,6].

The cecal intubation rate was 84.8% in our series, a value close to the international standard (≥ 90%), and showed no significant differences between the sedation and general anesthesia groups. This could indicate that, unlike ileal intubation, the type of sedation has less impact on cecal intubation.

Bowel preparation was adequate (Boston scale score ≥ 6) in 58.6% of cases. The relationship between good preparation and IIR was evident, where patients with adequate preparation achieved an IIR of 77.6%, compared with 44.1% in those with inadequate preparation, a statistically significant difference. These results reinforce the importance of optimizing bowel preparation in pediatrics, despite the logistical and adherence difficulties that this process can entail in children. Unlike the practice in adults, where a procedure can be canceled if preparation is insufficient, in pediatrics, the examination tends to be completed whenever possible to avoid repeating preparation and sedation.

In our study, neither the presence of a specialist trainee nor the endoscopist's years of experience after certification were associated with the success of ileal intubation. This finding is partially consistent with other reports suggesting that adequate supervision can mitigate differences attributable to individual experience.

The most frequent causes of incomplete procedures were inadequate bowel preparation and technical difficulty, consistent with previous studies[2,5,6]. No cases were reported in which the severity of the disease was the cause of procedure interruption, unlike what was observed in some other series.

Regarding complications, no major adverse events directly related to colonoscopy were recorded. Only two minor complications related to sedation and medications administered were reported: one case of rash and one case of transient hypertension. This is consistent with the low complication rate reported for endoscopic procedures in children, although we recognize that a larger sample size could allow for the detection of more infrequent adverse events.

Among the main limitations of our study are its observational design, the absence of interobserver assessment of the Boston scale, and the sample size, which may have limited the detection of other associations between the variables analyzed and the success of ileal intubation. Additionally, the fact that the procedures were performed by seven different endoscopists could have introduced variability in the results, given that individual technical skills do not always correlate directly with years of experience. Added to this is the use of different bowel preparation regimens, without rigorous standardization, which could have influenced the quality of preparation and, consequently, the performance indicators evaluated.

Conclusions

The results of this study correspond to the first Latin American data published on quality indicators in pediatric colonoscopy. We hope that the results presented will contribute to changing the conditions under which colonoscopies are performed, thereby avoiding repeat procedures in our patients and reducing costs at the institutional level.

Ethical Responsibilities

Human Beings and animals protection: Disclosure the authors state that the procedures were followed according to the Declaration of Helsinki and the World Medical Association regarding human experimentation developed for the medical community.

Data confidentiality: The authors state that they have followed the protocols of their Center and Local regulations on the publication of patient data.

Rights to privacy and informed consent: The authors have obtained the informed consent of the patients and/or subjects referred to in the article. This document is in the possession of the correspondence author.

Conflicts of Interest

Authors declare no conflict of interest regarding the present study.

Financial Disclosure

Authors state that no economic support has been associated with the present study.

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