Pediatric Surgery International (2019) 35:691–698
https://doi.org/10.1007/s00383-019-04467-4

ORIGINAL ARTICLE

Colectomies in children with inflammatory bowel disease: a national referral centre experience

Ancuta Muntean[1,2] · Ionica Stoica[1,2] · Suzanne Victoria McMahon[1] · Alan Mortell[1,2] · John Gillick[1,2] · Brian Terence Sweeney[1]

Accepted: 2 March 2019 / Published online: 7 March 2019

Abstract

Objectives Few studies have reported on the utility and efficacy of laparoscopic colectomy in the paediatric population. We aim to compare the characteristics and outcomes of children with inflammatory bowel disease (IBD) who underwent open vs laparoscopic treatment at our centre.

Methods A 10-year retrospective review was performed. Collected data included demographics, indication for surgery, operative characteristics, histopathology results, post-operative course and peri-operative complications.

Results A total of 58 patients underwent subtotal colectomy for IBD, with 38 laparoscopic procedures. The cohort included 33 males and 25 females with a mean age at surgery of 12.9 ± 3.3 years. The pre-operative diagnosis was ulcerative colitis in $n = 41$, Crohn's disease in $n = 5$ and indeterminate colitis in $n = 11$. There was an 84.2% concordance between the pre-operative and the post-operative histological diagnoses. Overall, 34 (58.6%) patients had complications, of which 19 (32.7%) patients required return to theatre. The complication rate was significantly smaller for laparoscopic compared to open procedures (42.1% vs 75%) as well as for elective compared with emergency colectomies (38.4% vs 75%). Four patients (10.5%) required conversion to open approach.

Conclusions Laparoscopic approach is feasible and safe in most paediatric patients with IBD and has a lower complication rate and better recovery than open procedures, especially when performed in an elective setting.

Keywords Laparoscopic · Open · Emergency · Elective · Colectomy · Growth · IBD

Introduction

Inflammatory bowel disease (IBD) represents a spectrum of disorders including Crohn's disease (CD), ulcerative colitis (UC) and IBD-unclassified (IBD-U) [1], with 5–25% of IBD cases occurring in the paediatric population [2]. The incidence of IBD in children is 5.2 per 100,000 children per year with a mean age at diagnosis of 11.9 years in United Kingdom and Republic of Ireland [3], while in the United States of America and Canada it is approximately 10 per 100,000 with a mean age at diagnosis of 12.3 years [4, 5]. With regard to the distribution of disease, 60% of cases were reported as CD, 28% as UC and the remaining 12% were labelled as IBD-U [3]. A systematic literature review showed that the incidence and prevalence of IBD are increasing with time and in different regions around the world [6].

Data suggest that surgery is required in approximately 30–40% of patients with UC and in approximately 70–80% of patients with CD at some point during their lifetime [7]. Surgical management of IBD is indicated when maximal medical therapy has failed with acute deterioration of the disease state, side effects to medication have developed or in cases of complications.

Laparoscopic approach for IBD is well described in the adult population. The adult literature is expansive with many studies and large numbers of cases while publications on paediatric patients are more scarce and with significantly smaller numbers [8]. The role of laparoscopy in the management of paediatric IBD is not clearly defined.

The aim of our study was to compare the characteristics and outcomes of paediatric patients who underwent open

✉ Ancuta Muntean
ancutza_muntean@yahoo.com

[1] Department of Paediatric Surgery, Our Lady's Children Hospital, Crumlin, Dublin, Ireland

[2] Department of Paediatric Surgery, Temple Street Children's Hospital, Dublin, Ireland

vs laparoscopic subtotal colectomy with end ileostomy for IBD at our centre.

Materials and methods

This study was a retrospective descriptive cohort study from a single tertiary paediatric national referral centre. We performed a retrospective chart review of all paediatric patients with a pre-operative diagnosis of IBD (ulcerative colitis, Crohn's disease, IBD-unclassified were considered), who underwent subtotal colectomy at Our Lady's Children's Hospital, Crumlin (Dublin, Ireland) from January 2007 to February 2017. A comparative study between laparoscopic vs open approach was performed. Since 2009, our preferred approach has been minimally invasive surgery. The paediatric population at our institution was defined as being younger than 16 years of age.

Data collection

Data collected included patient demographics (age, gender), indication for surgery, age at the time of diagnosis (recorded as the date when histological confirmation was made), age at the time of surgery, correlation between pre- and post-operative histopathology results, pre-operative medications, American Society of Anesthesiologists (ASA) grade, operative details including duration of surgery, rate of conversion for laparoscopic procedures, blood transfusion requirements, post-operative course including length of hospital stay, need for intensive care unit (ICU) monitoring, complication rate, use of antibiotics and parenteral nutrition. Also height, weight and body mass index (BMI) at surgery, at 6 months and 1 year follow-up were recorded. Standard deviation scores (SDS) were obtained and compared to standardised values for age.

The complications were classified as early if they occurred within 30 days post-operatively or late if they occurred later then 30 days. A procedure was classified as elective if performed as a scheduled case on an elective list, or as an emergency if performed as an unplanned event during a medical admission for a significant clinical deterioration despite maximal medical therapy.

Operative technique

At our institution, the preferred surgical procedure is laparoscopic subtotal colectomy with end ileostomy as an initial step in a staged approach. The completion of proctectomy with ileal pouch-anal anastomosis (IPAA) and ileostomy reversal is done as a subsequent procedure after the transition of patients to the adult care services.

Our surgical technique uses four or five ports (umbilical, left upper and lower quadrants, suprapubic and right lower quadrant at the stoma site). The ileostomy site is pre-operatively marked by the colorectal CNS. Following port insertion, a window is created in the mesosigmoid and the colonic mesentery is divided in an anticlockwise direction using a vessel sealing device (LigaSure™ Covidien). Once the colon is completely mobilised, the rectosigmoid is divided using a stapling service (Endo-GIA™ Covidien) and the colon is exteriorized through the right lower quadrant port site which becomes the site of the ileostomy.

Statistical analysis

Data were entered into a Microsoft Excel (Microsoft Office, 2010) spreadsheet and descriptive statistics were used for data analysis. Data were reported as mean ± SD or median and range. For comparison between groups, non-parametric Mann–Whitney test, Fisher test and Student *t* test were used. Statistical significance was considered for a p value < 0.05.

Ethical consideration

Ethical approval was obtained from Our Lady's Children's Hospital, Crumlin Institutional Research and Ethics Committee.

Results

Patient background and pre-operative disease characteristics

In the studied period (2007–2017), a total of 907 patients were managed for IBD in our centre. Of these, 58 required colectomy, with 38 patients undergoing a laparoscopic procedure. The cohort consisted of 33 males and 25 females, with a mean age at surgery of 12.9 ± 3.3. The median duration of symptoms until diagnosis (histopathological confirmation by biopsy) was 3 months (range 0–89 month) while the median period between the diagnosis of disease and surgery was 13 months (range 0–98 months). The demographic data for both laparoscopic and open cohorts are detailed in Table 1.

Pre-operatively, all patients had been treated with systemic glucocorticoids ($n = 58$), while 5-aminosalicylic acid (ASA) was used in 48 cases (82.7%). Additional immunomodulators were prescribed in 35 cases (60.3%) and biological agents in 26 cases (44.8%). Overall, 74.1% of patients had at least one unplanned admission to hospital before surgery, with 27.9% having more than three admissions. Pre-operatively, there was a mean of 4.7 total (planned and unplanned) admissions per patients, compared with a value

Table 1 Demographics

	Laparoscopic cohort	Open cohort	Total
Gender m:f	21:17	12:8	33:25
Duration of symptoms until diagnosis (m) (median, range)	2 (0–89)	8 (1–16)	3 (0–89)
Age at diagnosis (y) (mean ± SD)	11.4 ± 3.5	11.1 ± 3.2	11.3 ± 3.4
Duration of disease prior to surgery (m) (median, range)	19 (1–116)	15 (1–95)	16 (1–116)
Duration of medical treatment prior to surgery (m) (median, range)	15 (1–98)	8 (0–94)	13 (0–98)
Age at surgery (y) (mean ± SD)	13.6 ± 3.3	12.5 ± 3.3	12.9 ± 3.3

m months, *y* years, *SD* standard deviation

of 1.4 admissions per patient in the post-operative follow-up period.

Based on pre-operative biopsy results, UC was diagnosed in 41 patients, CD in 5 patients, while 11 patients were labelled as IBD-U. Pre-operative and post-operative histopathology reports were compared and concordance of diagnosis was measured. The findings were consistent in 48 cases, resulting in an overall concordance rate of 84.2%. One patient developed fulminant colitis as initial presentation and the diagnosis of CD was established post colectomy.

Indication for surgery and operative characteristics

Indications for surgery were persisting disease activity and symptoms despite optimal medical therapy in 27 patients (46.6%), acute severe exacerbation in 30 patients (51.7%) and side effects of medical therapy (cerebrovascular accident) in 1 patient (1.7%).

The colectomy rate within 1 year of diagnosis was 48.2% (28/58), while the 5-year colectomy rate was 93.1% (54/58). All surgeries performed were subtotal colectomy and formation of an end ileostomy.

The median American Society of Anesthesiologists (ASA) score was 3 (range 2–4).

The median operative time including anaesthetic time was significantly longer in the laparoscopic cohort (346 min vs 185 min). Looking at the yearly mean duration of laparoscopic procedures, this has decreased over time (Fig. 1). Median pre-operative haemoglobin was 101 g/dl (range 58–146 g/dl). A number of 23 patients (39.6%) received blood transfusions ranging from 150 ml to 5 units of packed red blood cells.

In the laparoscopic cohort, the conversion rate was 10.52% (4/38). Two cases were converted due to unclear anatomy secondary to bulky mesentery, one case with severe acute exacerbation and a very friable bowel wall and one case due to faecal contamination from a perforation at the level of the caecum.

Post-operative course: open vs laparoscopic approach

The comparative outcomes between the two approaches are illustrated in Table 2.

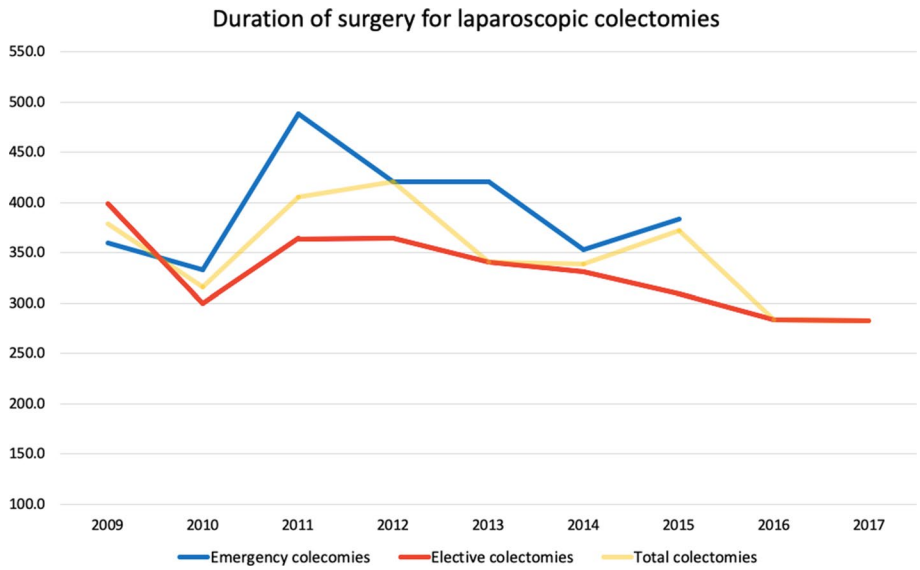

Fig. 1 Variance in operating times during study period

Table 2 Peri-operative data

	Laparoscopic cohort	Open cohort	*p* value
Operative time (including anaesthetic time) (min)	346 (241–564)	185 (120–290)	< 0.01
Days to clear fluids	3 (1–20)	3 (1–20)	ns
Days to regular diet	6 (2–28)	5 (2–24)	ns
Duration of iv antibiotics (days)	6.5 (3–37)	11 (5–35)	ns
Length of ICU stay (days)	2 (1–5)	2 (1–11)	ns
Length of post-operative stay (days)	8 (4–49)	16 (4–78)	0.01
Length of hospital stay (days)	14 (5–80)	27 (6–277)	< 0.01

All data are reported as median and range

ns Not statistically significant

Table 3 Total complications

	No of patients (no of complications)[a]		*p* value
	Laparoscopic approach ($n=38$)	Open approach ($n=20$)	
Total complications	16 (31)	15 (27)	0.02
Early complications	14 (24)	8 (16)	ns
Late complications	7 (7)	8 (11)	ns
Return to theatre	7 (7)	12 (13)	< 0.01

[a]Subcategories are not mutually exclusive

Patients that underwent a laparoscopic approach had a shorter post-operative stay (8 vs 16 days), as well as a shorter overall hospital stay. Twenty-seven patients required ICU admission with a median length of stay of 2 days (range 1–11 days), but no difference between the two cohorts. There was also no difference between the two groups with regard to median interval from surgery to starting clear fluids and establishing diet, nor in the duration of post-operative antibiotic treatment and epidural analgesia.

Complications

The complication rate for the entire population was 58.6%. The total rate of complications was significantly smaller in the laparoscopic compared with the open cohort (42.1% vs 75%). However, there was no difference when comparing the rates of early and late complications. Complication type and details are shown in Tables 3, 4 and 5. Small bowel obstruction had a significantly higher incidence in the open group ($p=0.04$). Surgical complications that required a return to theatre (Clavien–Dindo Grade III) were encountered in 18.42% ($n=7$) of patients in the laparoscopic cohort, while in the open cohort in 60% ($n=12$) ($p=0.002$). There were no mortalities.

Emergency vs elective procedures

A total of 32 colectomies (55.2%) were performed on an emergency basis, while 26 procedures (44.8%) were done electively (Table 6). In the post-operative course of the two groups, the variables found to be statistically significant were the duration to clear fluids and regular diet, duration of total parenteral nutrition, length of ICU admission, length of post-operative stay and the total length of hospital stay.

It was noted that 19 patients undergoing an emergency colectomy required a peri-operative blood transfusion, compared to 4 patients in the elective colectomy group, the difference being statistically significant ($p=0.001$) (Table 7). Looking at the mean pre-operative haemoglobin values for patients that did not receive blood transfusions ($n=35$), in the emergency group this was significantly lower than in the elective group (102 ± 15 vs 119 ± 18, $p=0.007$).

Regarding the frequency of complications between the two groups, it was noted that patients who underwent an emergency colectomy were more likely to have a post-operative complication compared with those who underwent an elective procedure (75% vs 38.4%, $p=0.007$) (Table 8).

Impact of surgery on growth for laparoscopic procedures

Height, weight and BMI at surgery, at 6 months and 1 year follow-up were recorded for the laparoscopic cohort.

Although the data revealed a lower median height SDS (-0.16, range -2.12 to 1.96) and BMI SDS (-0.4, range -4.43 to 2.32) at surgery and an improvement was noted at follow-up in both heights, with medians of 0.21 at 6 months and of 0.015 at 1 year, and in BMI, with medians of -0.005 at 6 months and of 0.005 at 1 year, there was no statistically significant difference (Table 9). Comparing emergency and elective colectomies at the time of surgery, a difference can be seen, with the emergency colectomy patients having considerably lower SD scores. When comparing the two groups at time of surgery and at 6 months post-operatively, although an improvement is

Table 4 Early complications (< 30 days post-operative)

Complication	Approach	No of patients (%)[a]	Details
Intra-abdominal abscess	Laparoscopic	5 (13.1%)	$n=4$ treated conservatively $n=1$ required return to theatre
	Open	3 (15%)	$n=2$ treated conservatively $n=1$ required return to theatre
Peristomal abscess	Laparoscopic	3 (7.8%)	$n=2$ treated conservatively $n=1$ required return to theatre
	Open	0	
Small bowel obstruction	Laparoscopic	2 (5.2%)	$n=1$ adhesive SBO, required return to theatre $n=1$ 180° twisted stoma, required return to theatre
	Open	2 (10%)	All required return to theatre
Wound infection	Laparoscopic	3 (7.8%)	All treated conservatively
	Open	1 (5%)	Treated conservatively
Wound dehiscence	Laparoscopic	4 (10.5%)	All healed by secondary intention
	Open	4 (20%)	$n=2$ healed by secondary intention $n=2$ required return to theatre
Stoma prolapse	Laparoscopic	1 (2.6%)	Required return to theatre
	Open	0	
Enterocutaneous fistula	Laparoscopic	1 (2.6%)	Required return to theatre
	Open	1 (5%)	Treated conservatively
Sepsis	Laparoscopic	2 (5.2%)	Upgrade of antibiotics regimen
	Open	2 (10%)	Upgrade of antibiotics regimen
Chest complications	Laparoscopic	3 (7.8%)	$n=2$ pneumonia $n=1$ pleural effusion
	Open	3 (15%)	$n=2$ parapneumonic effusion $n=1$ empyema—required chest drain insertion

[a]Subcategories are not mutually exclusive

Table 5 Late complications (> 30 days post-operative)

Complication	Approach	No of patients (%)[a]	Details
Small bowel obstruction	Laparoscopic	3 (7.8%)	$n=1$ required return to theatre $n=2$ treated conservatively
	Open	6 (30%)	$n=5$ required return to theatre $n=1$ treated conservatively
Stoma related	Laparoscopic	3 (7.8%)	$n=1$ stoma stenosis (managed with dilatations) $n=1$ stoma retraction (revision of stoma) $n=1$ stoma prolapse (managed conservatively)
	Open	5 (20%)	$n=1$ stoma prolapse (managed conservatively) $n=1$ peristomal dehiscence (managed conservatively) $n=3$ stoma stenosis (managed with dilatations)
Wound dehiscence	Laparoscopic	1 (2.6%)	Negative pressure wound therapy
	Open	0	

[a]Subcategories are not mutually exclusive

noted in both groups, this was not found to be statistically significant. The comparisons were performed using the software provided by WHO (World Health Organisation): WHO Anthro, which is designed for assessing growth and development of children in accordance to childhood growth standards [9, 10].

No relevant relationship was demonstrated between BMI and conversion rate.

Patients were followed up by the surgical team for a median of 2.3 years (range 1 month–8 years); this was continued by the Gastroenterology team until transitioning to adult services, around the age of 16 years.

Table 6 Emergency vs elective colectomies: demographic and peri-operative data

	Emergency	Elective	*p* value
No of cases	32	26	–
Gender M/F	16/16	17/9	ns
Duration of symptoms until diagnosis (m) (median, range)	3 (0–12)	3 (0–89)	ns
Age at diagnosis (y) (mean ± SD)	11.54 ± 3.39	11.04 ± 3.46	ns
Duration of disease prior to surgery (m) (median, range)	10 (1–95)	24 (5-116)	ns
Duration of medical treatment prior to surgery (m) (median, range)	4 (0–94)	17 (3–98)	ns
Age at surgery (y) (mean ± SD)	12.85 ± 3.44	13.04 ± 3.33	ns
Days to clear fluids (median, range)	4 (1–20)	3 (1–7)	0.02
Days to regular diet (median, range)	6.5 (2–28)	5 (2–14)	0.04
Days of TPN (median, range)	7 (0–24)	0 (0–8)	< 0.01
Length of ICU stay (d) (median, range)	2 (0–11)	0 (0–2)	< 0.01
Length of post-operative stay (d) (median, range)	14.5 (5–78)	7.5 (4–20)	< 0.01
Length of hospital stay (d) (median, range)	27 (6-277)	9 (5–36)	< 0.01

d days, *m* months, *y* years, *SD* standard deviation

Table 7 Correlation between emergency vs elective colectomy and blood transfusions

No of colectomies	Blood transfusions		
	Yes	No	Total
Emergency	19	13	32
Elective	4	22	26
Total	23	35	58

Two-tailed Fisher exact test = 0.001 (95% CI)

Table 8 Correlation between emergency vs elective colectomy and complications

No of colectomies	Complications		
	Yes	No	Total
Emergency	24	8	32
Elective	10	16	26
Total	34	24	58

Two-tailed Fisher exact test = 0.007 (95% CI)

Discussion

Until now, only a small number of publications have reported on the use of laparoscopy for the treatment of IBD in the paediatric population. Since the first reports, published in 2002 [11–13], there have been several studies to retrospectively compare the open vs laparoscopic approach [8, 13].

The aim of this study was to describe the characteristics and outcomes of the paediatric population who underwent a subtotal colectomy at our institution and to compare results for laparoscopic vs open approach. In Ireland, the incidence of IBD has seen a significant increase in recent years [14, 15]. During a 10-year period, a total of 907 children were diagnosed with an inflammatory bowel disease and 58 of these required surgery, with the main indications being disease refractory to medical treatment and acute severe exacerbation. In this series, more than 90% of colectomies for IBD occurred within 5 years of having established the diagnosis. The total number of admissions per patient decreased from a value of 4.7 pre-operatively to 1.4 post-operatively, suggesting both that children with IBD consume a large amount

Table 9 Pre-operative and post-operative SDS scores for height and BMI

	At surgery	At 6 months follow-up	At 1 year follow-up	*p* value[a]	*p* value[b]
Median height SDS (range)	−0.16 (−2.12 to 1.96)	0.21 (−2.32 to 2.6)	0.015 (−1.75 to 2.44)	0.87	0.35
Median BMI SDS (range)	−0.4 (−4.43 to 2.32)	−0.005 (−4.15 to 2.28)	0.005 (−3.66 to 2.2)	0.31	0.24

[a]Between measurements at surgery and at 6 months follow-up

[b]Between measurements at surgery and at 1 year follow-up

of resources prior to colectomy and that resource consumption diminishes in years following surgery, as postulated by Kelley-Quon et al. [16].

Our results were similar to the data in the literature demonstrating that although laparoscopy has a longer operative time, it provides better post-operative outcomes with regard to length of hospital stay, return to normal activities and cosmetic results while the complication rate was smaller, supporting the feasibility of minimally invasive surgery in children.

In our institution, the current practice is to complete a subtotal colectomy and end ileostomy. Reconstructive procedures, where appropriate, are performed by adult surgeons when the medical condition has improved, medication has been weaned and patients are old enough to fully understand their decision and the potential complications with long-term implications such as decreased fertility. There are only a few studies reporting the outcomes following laparoscopic colectomy as the initial procedure in a staged approach [17, 18], limiting the comparison of the results.

Our median operative time for laparoscopic approach was longer (346 min) compared with other reports (258 min, Diamond et al. 270 min, Flores et al. 215 min Pini-Prato et al.), but this is probably because we also included the anaesthetic time and the majority of patients required placement of a central venous access catheter [17–19].

In the laparoscopic group, conversion to an open approach was necessary in 10.5% of patients, which is higher than the conversion rate reported in the literature (7%) [17].

The post-operative course with introduction of oral intake and duration of iv antibiotic did not significantly differ between the two approaches, and the results were comparable with what has already been reported in the literature [17, 18].

Our series of patients had a moderately high complication rate of 58.6%, with 32.7% of patients requiring a return to theatre. The laparoscopic group encountered significantly fewer complications than the open group. Post-operative infections were the most common complication in our study (79.1% of all complications) and this most likely can be attributed to the fact that the majority of patients were on active treatment at the time of surgery. This is consistent with prior reports of post-operative complications in children undergoing colectomy for IBD [17, 20]. Bowel obstruction had a significantly lower occurrence in the laparoscopic group (13% vs 40%), which is comparable to other studies (16%—Mattioli et al., 16%—Diamond et al.) [17, 21].

The rate of post-operative complications was higher in patients who underwent an emergency procedure compared with those who underwent an elective one (75% vs 38%). Similar findings were reported in the literature (90% vs 50%) [20], although our complication rates were lower.

The timing of surgery is essential and, where possible, the aim is to avoid the patient deteriorating to a degree where an emergency colectomy would be required. Our data suggest that the necessity to perform a colectomy as an emergency is burdened by a higher complication rate, higher need for blood transfusion and total parenteral nutrition and longer inpatient stay with ICU admission. Elective colectomy offers a shorter hospital stay, a decrease in medications and, therefore, side effects, with a lower risk of complications.

For these reasons, the decision for colectomy does not rest solely in the hands of the surgeon, but should be guided by the multidisciplinary team that coordinates the therapeutic path of any patient with an IBD.

There is evidence demonstrating the significant impact of IBD upon growth and nutrition in the paediatric population with growth impairment typically more prominent in CD than UC [22, 23]. Our data showed an improvement in nutritional status after the surgery, but the difference was not statistically significant.

Conclusions

Our experience is in line with what has been previously published in the literature and highlights that the laparoscopic approach for subtotal colectomy is a feasible and safe option in paediatric patients with IBD, especially when performed in an elective setting. Further studies on the long-term outcomes of laparoscopic colectomy in the paediatric population are essential to fully understand the optimal timing for surgery and risk factors for developing complications.

Limitations

The present study has several limitations. It is a retrospective analysis; the data were collected by chart review and the accuracy was dependent on the quality of patient record keeping. Also the study was based on a small sample size.

Acknowledgements The authors wish to thank the gastroenterology team and colorectal clinical nurse specialists at Our Lady's Children Hospital, Crumlin, Dublin, for the excellent medical care provided to our patients.

Author contributions Concept and design of the study: AM, IS, SVM, AM, JG, BTS. Data collection: AM, IS. Data analysis and interpretation: AM, IS, SVM. Drafting the manuscript: AM, IS, SVM. Critical revision of the manuscript: AM, IS, SVM, AM, JG, BTS. Final approval of the version to be published: AM, IS, SVM, AM, JG, BTS.

Funding No funding was received for this study.

Compliance with ethical standards

Conflict of interest The authors declare no conflict of interest.

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