



Risk factors of post-polypectomy bleeding and recurrence in children with colorectal polyps after endoscopic mucosal resection: a retrospective cohort study

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Background: The incidence rate of colorectal polyps in children has gradually increased in recent years. It is still unclear whether endoscopic mucosal resection (EMR) can be performed in children with colorectal polyps as well as their incidences of post-polypectomy bleeding and recurrence. This retrospective study was performed to explore the feasibility of EMR in children with colorectal polyps and analyze the risk factors of post-polypectomy bleeding and recurrence.

Methods: Patients aged younger than 18 years diagnosed with colorectal polyps and received EMR for polypectomy between January 2017 and December 2021 were included in this study. The baseline data of included patients were retrospectively collected. All complications related to polypectomy were recorded during follow up via telephone, internet, or outpatient department, including post-polypectomy bleeding, perforation and polyp recurrence. Patients with and without post-polypectomy complications were divided into 2 groups. The risk factors of post-polypectomy bleeding and polyp recurrence were analyzed using multivariable logistic regression models after adjusting potential risk factors using univariable regression models.

Results: A total of 589 patients were included in this retrospective study. There were 333 male patients and 256 female patients, and their average age was 4.4±1.9 years old. The average diameter of their polyps was 8.4±2.8 mm, and 542 (92.0%) polyps presented as pedunculated lesions. A total of 540 (91.7%) polyps were diagnosed as juvenile polyps and 509 (86.4%) patients had only 1 polyp. There were a total of 75 cases of post-polypectomy complications (12.7%). The most common complication was early post-polypectomy bleeding (5.3%), followed by polyp recurrence (3.7%). Post-polypectomy bleeding occurred the most on the third and fourth day after EMR polypectomy. Larger polyps (OR =1.742, P<0.001), sessile lesions (OR =3.150, P=0.019), and multiple polyps (OR =4.372, P=0.003) were identified to be related to the incidence of post-polypectomy bleeding. Besides, sessile lesions (OR =3.887, P=0.026) were identified as the main risk factor and older patients (OR =0.606, P=0.004) had lower potential for post-polypectomy recurrence.

Conclusions: More attention should be paid to large, sessile, and multiple polyps during the procedure of EMR in children. The small number of patients in this study limits further analysis of results and a large sample study should be performed.

Keywords: Pediatric polyp; post-polypectomy bleeding; recurrence; endoscopic mucosal resection (EMR); retrospective study

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Introduction

Colorectal polyps are common benign lesions of the digestive tract and can be found in patients of all ages (1). Most colorectal polyps in adult patients are found during early cancer screening by colonoscopy due to family or personal history of colorectal cancer (2). Polypectomy under colonoscopy is often performed to remove colorectal polyps and achieves a good curative effect, thereby preventing the incidence of colorectal cancer. With the development of endoscopic technology, pediatric endoscopy has become more widespread, and the incidence rate of colorectal polyps in children has gradually increased in recent years (3). Unlike adult patients, pediatric colorectal polyps mostly occur in children aged from 2 to 5 years and they are usually found due to clinical symptoms such as abdominal pain, abdominal distension, vomiting, and bloody stool (4). Once diagnosed, polypectomy should be performed immediately to relieve symptoms.

Different techniques are used to remove different sizes of colorectal polyps at present. For small polyps in the colon and rectum, generally within 3 mm in diameter, biopsy forceps can be directly used to remove them (5). Larger polyps, within 7 mm in diameter, can be removed by the cold snare technique (6). Hot biopsy forceps were also considered as one of the optional treatment methods for larger polyps in the past. However, due to the high risk of post-polypectomy bleeding and perforation, the utilization rate of hot biopsy forceps is low nowadays (7). For giant colorectal polyps, which can be larger than 15–20 mm in diameter, piecemeal resection should be performed to remove them completely (8). Endoscopic mucosal resection (EMR) technology, which are commonly used in adult patients with adenomatous polyps or early cancer, are less applied in pediatric patients, considering they have a large resection range and deep resection depth (9–11). EMR have been widely accepted for adult patients because of their advantages of complete resection of lesions, small trauma, and good prognosis (12,13). However, it is still unclear whether EMR can be performed in children and whether they can cause severe complications.

In recent years, our pediatric digestive endoscopy center has been committed to applying EMR technology for polypectomy in children. In view of the fact that there are few reports of children with colorectal polyps undergoing polypectomy with EMR worldwide, we performed this retrospective study to summarize the clinical experience of polypectomy using EMR in the past 5 years and analyze the

risk factors of post-polypectomy bleeding and recurrence in children. We present the following article in accordance with the STROBE reporting checklist (available at <https://tp.amegroups.com/article/view/10.21037/tp-22-518/rc>).

Methods

This was a retrospective study performed in the Affiliated Hospital of Jiangnan University and the protocol of this study was submitted to and approved by the ethics committee of the Affiliated Hospital of Jiangnan University (No. 20220013). The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). Due to the nature of the retrospective study, individual consent was waived.

The following patients were included in this study: all patients aged younger than 18 years, diagnosed with colorectal polyps, and received EMR for polypectomy between January 2017 and December 2021. The following patients were excluded: those who underwent polypectomy in other centers before the commencement of this study, those who received drugs potentially increasing the incidence of post-polypectomy complications, those who had immediate bleeding after polypectomy, and those whose data was incomplete or lost to follow-up within the 14 days after polypectomy.

The following data was retrospectively collected in order to determine the risk factors of post-polypectomy complications: patient sex, age, polyp size (maximum diameter), polyp location (right side colon, left side colon, and rectum), polyp morphology (pedunculated lesion and sessile lesion), polyp pathological type (juvenile polyps, hyperplastic polyps, inflammatory polyps, adenomas, and others), and number of polyps (single and multiple). All complications related to polypectomy were recorded according to collected data during follow-up, including post-polypectomy bleeding, perforation, polyp recurrence, and some other complications. Post-polypectomy bleeding was defined as early bleeding and delayed bleeding requiring endoscopic hemostasis. Early post-polypectomy bleeding occurred within 14 days after EMR of polypectomy and delayed bleeding occurred beyond the 14 days after polypectomy. Major bleeding was defined as bleeding requiring blood transfusions or resulting in decreases in hemoglobin levels of more than 20 g/L. Post-polypectomy perforation was defined as defect of the colon wall needing endoscopic or surgical intervention. Polyp recurrence was defined as the recurrence of polyps at the site where EMR

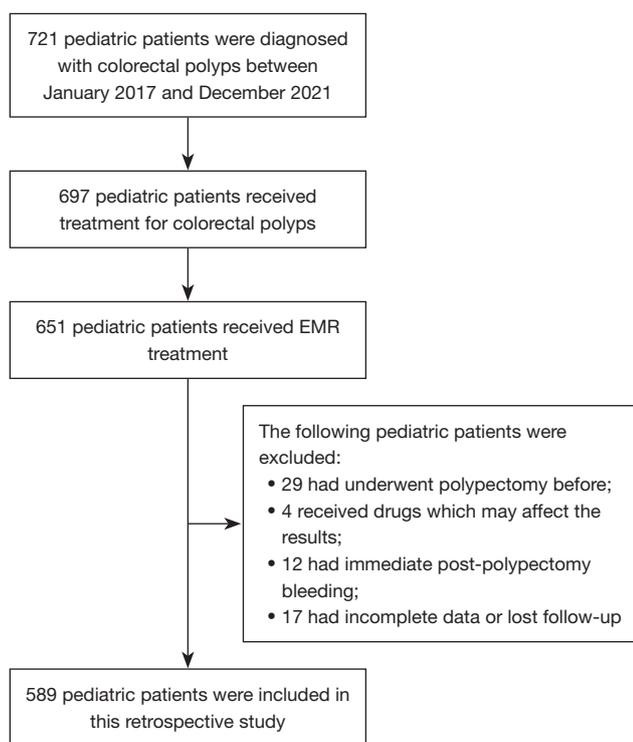


Figure 1 Flow chart of patient selection. EMR, endoscopic mucosal resection.

was performed during follow-up. Some other complications or newly developed symptoms were also recorded such as abdominal pain, diarrhea, and constipation. All included patients were followed up for at least 14 days via telephone, internet, or outpatient department, and some patients were followed up for several years to determine that there was no polyp recurrence.

Statistical analysis

All statistical analysis was performed using SPSS 20.0 (IBM Corp. NY, USA). Patients with and without post-polypectomy complications were divided into 2 groups. All continuous data in the 2 groups were expressed as mean and standard deviation and all categorical data were expressed as number and percentage. Continuous data were compared between the 2 groups using Student's *t*-test and categorical data were compared using the Chi-square test. The risk factors of post-polypectomy bleeding and polyp recurrence were analyzed using multivariable logistic regression models after adjusting potential risk factors using univariable regression models. A value of 0.05 was set as the

cut-off of P value, and two-sided P value <0.05 was defined as significantly different.

Results

Pediatric patients with colorectal polyps who were admitted to our hospital between January 2017 and December 2021 were included in this study. Of all 721 patients, 697 pediatric patients received treatment for colorectal polyps and 651 patients received EMR treatment. Eventually, 589 patients were included in this retrospective study and 62 patients were excluded according to the exclusion criteria, as shown in *Figure 1*.

The baseline data of the included patients are shown in *Table 1*. There were 333 male patients and 256 female patients. Their average age was 4.4 ± 1.9 years old and the average diameter of their polyps was 8.4 ± 2.8 mm. A total of 168 (28.5%) polyps were located at the right side of the colon, 219 (37.2%) were located at the left side of the colon, and 202 (34.3%) were located at the rectum. A total of 542 (92.0%) polyps presented as pedunculated lesions and 47 (8.0%) polyps presented as sessile lesions. According to the results of pathological examination, 540 (91.7%) polyps were diagnosed as juvenile polyps, 23 (3.9%) were diagnosed as hyperplastic polyps, 12 (2.0%) were diagnosed as inflammatory polyps, 9 (1.5%) were diagnosed as adenomas, and 5 (0.8%) were diagnosed as others. A total of 509 (86.4%) patients had only 1 polyp and 80 (13.6%) patients had no less than 2 polyps.

Complications which occurred in the included patients are listed in *Table 2*. There were a total of 75 cases of post-polypectomy complications. The most common complication was early post-polypectomy bleeding (31, 5.3%), followed by polyp recurrence (22, 3.7%) and other complications (19, 3.2%). Two patients suffered delayed post-polypectomy bleeding and only 1 patient was diagnosed with post-polypectomy perforation. The occurrence of early post-polypectomy bleeding every day after the operation was recorded in *Figure 2*. It was found that the number of cases of post-polypectomy bleeding was the highest on the third and fourth day after EMR polypectomy, with 7 cases and 5 cases, respectively. Four cases of post-polypectomy bleeding occurred on the first day after EMR polypectomy and 5 cases occurred 1 week after polypectomy.

The included patients were then divided into post-polypectomy bleeding and none bleeding groups, and post-

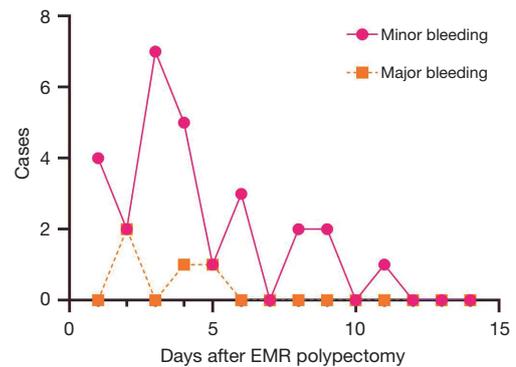
Table 1 Baseline data of included patients

Parameters	Value
Total	589
Sex	
Male	333 (56.5%)
Female	256 (43.5%)
Age (years)	4.4±1.9
Polyp size (mm)	8.4±2.8
Polyp location	
Right side colon	168 (28.5%)
Left side colon	219 (37.2%)
Rectum	202 (34.3%)
Polyp morphology	
Pedunculated lesions	542 (92.0%)
Sessile lesions	47 (8.0%)
Polyp pathology	
Juvenile polyps	540 (91.7%)
Hyperplastic polyps	23 (3.9%)
Inflammatory polyps	12 (2.0%)
Adenomas	9 (1.5%)
Others	5 (0.8%)
Polyp number	
Single	509 (86.4%)
Multiple	80 (13.6%)

Continuous data were expressed as mean and standard deviation, and categorical data were expressed as number and percentage.

Table 2 Complications which occurred in included patients

Parameters	n (%)
Total	589
All complications	75 (12.7)
Early post-polypectomy bleeding	31 (5.3)
Delayed post-polypectomy bleeding	2 (0.3)
Post-polypectomy perforation	1 (0.2)
Polyp recurrence	22 (3.7)
Some other complications	19 (3.2)

**Figure 2** Period of early post-polypectomy bleeding occurrence. EMR, endoscopic mucosal resection.

polypectomy recurrence and none recurrence groups. Comparisons of baseline data between patients with and without complications are shown in *Table 3*. It was found that patients with post-polypectomy bleeding were younger than those without bleeding (3.7±1.7 versus 4.4±1.8 years, $P=0.039$) and they had larger polyps than those without bleeding (11.7±2.1 versus 8.2±2.7 mm, $P<0.001$). More polyps in patients with post-polypectomy bleeding presented as sessile lesions (19.4% versus 7.3%, $P=0.016$). There were significantly more inflammatory polyps in patients with post-polypectomy bleeding than in those without bleeding (9.7% versus 1.6%, $P=0.047$). In addition, patients with post-polypectomy bleeding had multiple polyps (29.0% versus 12.7%, $P=0.021$). On the other hand, it was also found that patients with post-polypectomy recurrence were younger than those without recurrence (3.5±1.7 versus 4.4±1.9 years, $P=0.026$) and more polyps in these patients presented as sessile lesions (27.3% versus 7.2%, $P=0.001$). Patients with post-polypectomy recurrence had multiple polyps (31.8% versus 12.9%, $P=0.011$).

The risk factors of post-polypectomy bleeding were analyzed by multivariable logistic regression models, as shown in *Table 4*. The results indicated that larger polyps, sessile lesions, and multiple polyps were identified to be related to the incidence of post-polypectomy bleeding. Besides, risk factors of post-polypectomy recurrence were analyzed as shown in *Table 5*. Sessile lesions were identified as the main risk factor and older patients had lower potential for post-polypectomy recurrence.

Discussion

This retrospective study was performed to investigate the

Table 3 Comparisons of baseline data between patients with and without complications

Parameters	Post-polypectomy bleeding			Post-polypectomy recurrence		
	No	Yes	P value	No	Yes	P value
Number	558	31		567	22	
Sex						
Male	320 (57.3%)	13 (41.9%)	0.092	322 (56.8%)	11 (50%)	0.528
Female	238 (42.7%)	18 (58.1%)		245 (43.2%)	11 (50%)	
Age, years	4.4±1.8	3.7±1.7	0.039	4.4±1.9	3.5±1.7	0.026
Polyp size (mm)	8.2±2.7	11.7±2.1	<0.001	8.4±2.8	9.4±3.1	0.079
Polyp location						
Right side colon	157 (28.1%)	11 (35.5%)	0.224	160 (28.2%)	8 (36.4%)	0.662
Left side colon	212 (38.0%)	7 (22.6%)		211 (37.2%)	8 (36.4%)	
Rectum	189 (33.9%)	13 (41.9%)		196 (34.6%)	6 (27.3%)	
Polyp morphology						
Pedunculated lesions	517 (92.7%)	25 (80.6%)	0.016	526 (92.8%)	16 (72.7%)	0.001
Sessile lesions	41 (7.3%)	6 (19.4%)		41 (7.2%)	6 (27.3%)	
Polyp pathology						
Juvenile polyps	514 (92.1%)	26 (83.9%)	0.047	519 (91.5%)	21 (95.5%)	0.899
Hyperplastic polyps	23 (4.1%)	0 (0%)		22 (3.9%)	1 (4.5%)	
Inflammatory polyps	9 (1.6%)	3 (9.7%)		12 (2.1%)	0 (0%)	
Adenomas	8 (1.4%)	1 (3.2%)		9 (1.6%)	0 (0%)	
Others	4 (0.7%)	1 (3.2%)		5 (0.9%)	0 (0%)	
Polyp number						
Single	487 (87.3%)	22 (71.0%)	0.021	494 (87.1%)	15 (68.2%)	0.011
Multiple	71 (12.7%)	9 (29.0%)		73 (12.9%)	7 (31.8%)	

Continuous data were expressed as mean and standard deviation, and categorical data were expressed as number and percentage.

Table 4 Risk factors of post-polypectomy bleeding analyzed by multivariable logistic regression models

Parameters	OR	95% CI	P value
Older patients	0.870	0.697–1.086	0.217
Larger polyps	1.742	1.458–2.082	<0.001
Sessile versus pedunculated lesions	3.150	1.208–8.218	0.019
Juvenile versus non-juvenile polyps	1.512	0.893–2.558	0.124
Multiple versus single polyps	4.372	1.639–11.664	0.003

OR, odds ratio; CI, confidence interval.

Table 5 Risk factors of post-polypectomy recurrence analyzed by multivariable logistic regression models

Parameters	OR	95% CI	P value
Older patients	0.606	0.433–0.849	0.004
Sessile versus pedunculated lesions	3.887	1.175–12.863	0.026
Multiple versus single polyps	2.068	0.673–6.362	0.205

OR, odds ratio; CI, confidence interval.

application of EMR in the treatment of pediatric colorectal polyps. The results indicated that EMR was safe and efficient in the treatment of colorectal polyps. The main postoperative complication was early postoperative bleeding, which usually occurs within 4 days after polypectomy, and 3.7% of patients would have polyp recurrence after polypectomy. Multivariable logistic regression analysis showed that the risk factors of post-polypectomy bleeding were mainly the parameters of polyps, such as the size, morphology, and number of polyps. The main risk factor of polyp recurrence was the morphology of polyps, and the incidence of polyp recurrence may decrease along with the increase of age in children. To the best of our knowledge, this is the first study reporting the application of EMR for pediatric colorectal polyps and may provide some evidence for EMR use in children in the future.

The average age of the patients with colorectal polyps included in this study was 4.4 years old, the diameter of most polyps was less than 1 cm, and most of the included patients were admitted to our hospital due to bloody stool. All the included patients underwent polypectomy with EMR. Compared with endoscopic submucosal dissection, the depth of EMR resection is shallower and the safety is higher (14,15). Compared with the traditional cold snare technique, EMR has advantages in the treatment of large polyps and sessile polyps, and may be more effective in reducing the recurrence of polyps. The incidence of total complications in our study was 12.7%. The most common complication was early post-polypectomy bleeding, with an incidence rate of 5.3%, which was similar to a previous study (16). Besides, the incidence of post-polypectomy recurrence was 3.7%, which was slightly lower than a previous study (16). These findings indicated that EMR acted as a feasible treatment for colorectal polyps in children.

Our study identified the size, morphology, and number of polyps as the important risk factors of early post-polypectomy bleeding. Previous studies also reported that polyp size and morphology were related to the incidence of post-polypectomy bleeding (17,18). They also found that polyp location could affect the incidence of post-polypectomy bleeding (17), but our study did not determine the relationship between them. Delayed post-polypectomy bleeding is an infrequent but serious complication after colorectal polypectomy, and it was found to be associated with chronic diseases, polyp size, and location (19,20). However, only 2 cases of delayed post-polypectomy bleeding occurred in our study and it is impossible to determine its risk factors.

Long term follow-up is often performed after colorectal polypectomy in adult patients in order to exclude or detect the occurrence of colorectal cancer early (21). However, there are few studies on this issue to date. Our study found that the incidence of polyp recurrence in pediatric patients after EMR was 3.7%, the incidence of recurrence for sessile polyps was higher than for pedunculated polyps, and the incidence of recurrence in younger patients was higher than that of older patients. Previous study has found that the pathological type of polyps was related to polyp recurrence (16). However, more than 90% of polyps in our study were juvenile polyps, and no relationship between the pathological type of polyps and recurrence has been found.

There were some limitations to be noted in this study. First, as this study was a single-center retrospective study, the small number of patients may lead to some limitations in the results. Second, due to the low incidence of complications in this study, some confounding biases may inevitably occur in the analysis of risk factors of post-polypectomy complications. Third, the nature of a retrospective study design made it hard to collect the data of EMR procedures, thus it is impossible to analyze the influence of intraoperative factors such as EMR duration and bowel preparation on post-polypectomy complications.

In summary, our study is the first to use EMR for the resection of colorectal polyps in children. The results showed that the incidence of complications after EMR resection of colorectal polyps in children was low, and the most common complication was post-polypectomy bleeding. Attention should be paid to the treatment of large, sessile, and multiple polyps during EMR to reduce the incidence of post-polypectomy bleeding. Moreover, follow-up should be strengthened in younger patients after polypectomy in order to discover and manage the recurrence of polyps early.

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Footnote

Reporting Checklist: The authors have completed the STROBE reporting checklist. Available at <https://tp.amegroups.com/article/view/10.21037/tp-22-518/rc>

Data Sharing Statement: Available at <https://tp.amegroups.com/article/view/10.21037/tp-22-518/dss>

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at <https://tp.amegroups.com/article/view/10.21037/tp-22-518/coif>). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The protocol of this study was submitted to and approved by the ethics committee of the Affiliated Hospital of Jiangnan University (No. 20220013). The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). Due to the nature of the retrospective study, individual consent was waived.

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