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Effects of Different Endoscopic Treatment Methods on Bleeding Complications in Pedunculated Colorectal Polyps

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Introduction: Endoscopic resection of colorectal polyps offers several advantages, including ease of performance, reduced surgical time, and preservation of anatomic structures. However, bleeding remains a common complication of the endoscopic treatment of colorectal polyps, particularly with a higher incidence of postprocedural bleeding in pedunculated colorectal polyps. Currently, there is no optimal method for the resection of pedunculated colorectal polyps. The aim of this study was to compare the postresection bleeding outcomes of 3 different techniques for the removal of pedunculated colorectal polyps.

Methods: A retrospective analysis of postresection bleeding following the use of 3 techniques—endoscopic mucosal resection, endoscopic submucosal dissection (ESD), and prophylactic clips was conducted on pedunculated colorectal polyps.

Results: The incidence of delayed hemorrhage after endoscopic mucosal resection resection of pedunculated colorectal polyps was highest (18.9%). In contrast, the incidence rates of delayed bleeding in the ESD and prophylactic clip groups were 4.3% and 5.9%, respectively ($P < 0.05$). The intraoperative bleeding rate was highest in the ESD group (6.5%), while no intraoperative bleeding occurred in the other 2 groups, indicating a statistically significant difference among the 3 groups ($P < 0.05$). However, the need for endoscopic hemostasis due to delayed bleeding was not significantly different among the groups ($P > 0.05$).

Conclusion: Employing endoscopic submucosal dissection (ESD) and clamping the stalk of pedunculated polyps before removal can effectively reduce the risk of postpolypectomy bleeding. Furthermore, ESD offers distinct advantages for the removal of larger polyps, both at the stalk and the head.

Key Words: pedunculated colorectal polyps, delayed bleeding, endoscopic mucosal resection, endoscopic submucosal dissection, prophylactic clips

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Colorectal cancer is the third most common malignant tumor globally and has the second highest mortality rate.[1,2] The incidence of colorectal cancer continues to rise in South America, Asia, Eastern Europe, and countries undergoing socioeconomic transitions.[1] Most colorectal cancers originate from adenomatous polyps in the colon and rectum.[3] Colorectal polyps are precancerous lesions that can lead to colorectal cancer. Numerous studies have demonstrated that early endoscopic resection of colorectal polyps significantly reduces the incidence of colorectal cancer.[4–6] The advent of endoscopic technology and new equipment has expanded the techniques available for removing colorectal polyps. Endoscopic treatments for colorectal polyps vary based on their size, morphology, and location.[2,3] For example, cold snare polypectomy (CSP) is a safe and effective method for resecting polyps < 10 mm. Cold forceps polypectomy (CFP) and hot forceps polypectomy (HFP) are techniques used to remove polyps < 5 mm. Heat snare polypectomy (HSP) is recommended for removing pedunculated polyps with a head < 2 cm and a stalk < 0.5 cm. Commonly used techniques also include endoscopic mucosal resection (EMR), endoscopic piecemeal mucosal resection (EPMR), endoscopic submucosal dissection (ESD), and argon plasma coagulation (APC).

Endoscopic resection of colorectal polyps remains the standard treatment for colorectal tumors owing to its advantages, including simplicity, reduced procedure time, and preservation of the anatomic structure.[4,7] However, bleeding and perforation are common complications in the endoscopic treatment of colorectal tumors. The incidence of bleeding varies among different reports, ranging from 0.3% to 10.2%,[8] and the incidence rate of perforation is 0.6% to 1.9%.[9,10] Bleeding can be manifested as intraoperative bleeding and postoperative delayed bleeding. Intraprocedural bleeding is bleeding that occurs during endoscopic procedures that last > 60 seconds or require endoscopic intervention. Postoperative delayed bleeding is bleeding that occurs after endoscopic surgery within 30 days of polyp removal and requires an emergency department visit, hospitalization, or re-endoscopy, angiography, or surgery.[11]

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This study protocol was reviewed and approved by the Institutional Review Board of Xuyi People's Hospital, Clinical Medical College of Yangzhou University, approval number "LLKSSC2024-04." The requirement for written consent was waived based on the retrospective design.

All data generated or analyzed during this study are included in this article. Further enquiries can be directed to the corresponding author.

The author declares no conflicts of interest.

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The incidence of delayed bleeding varies based on several factors, including the type of polypectomy performed, the size and morphology of the polyp, and patient-related factors such as anticoagulant use and comorbidities.[12,13]

Despite their amenability to endoscopic removal, pedunculated colorectal polyps remain a challenge due to the potential for delayed bleeding.[14] This risk is compounded by the presence of larger blood vessels at the base of these polyps.[15] Retrospective studies have highlighted certain procedural factors that may contribute to this complication. For example, root injection and preventive clamping before polypectomy have been identified as potential risk factors for delayed bleeding.[8] The European Society of Gastrointestinal Endoscopy (ESGE) Guideline[11] offers some guidance in addressing this issue. For pedicled colorectal polyps with a head size ≥ 2 cm or stalk width ≥ 1 cm, the use of diluted epinephrine injection and/or mechanical hemostasis to prevent bleeding immediately after polypectomy is recommended. However, the recommendation is weak, and the quality of the evidence is low.

Given the current limitations in evidence, it is imperative that we continue to collect and analyze clinical data on the endoscopic treatment of pedunculated colorectal polyps. A larger pool of data would not only strengthen our understanding of the risk factors involved but also aid in the development of more effective and safer treatment strategies. Therefore, this study aims to retrospectively analyze the effects of different endoscopic treatment methods (EMR, ESD, and prophylactic clips) on delayed bleeding in pedunculated colorectal polyps.

METHODS

Study Design

This retrospective analysis aims to evaluate the incidence and risk factors for delayed bleeding following the removal of pedunculated colorectal polyps through 3 techniques: endoscopic mucosal resection (EMR), endoscopic submucosal dissection (ESD), and prophylactic clipping. The data were collected from hospitalized patients who underwent polypectomy at Xuyi People's Hospital, Clinical Medical College of Yangzhou University, from January 2019 to May 2024. Institutional review board approval was obtained before initiating the study.

Patient Selection

The study included patients who underwent polypectomy for pedunculated colorectal polyps. The inclusion criteria were as follows: (1) aged 18 years or older; (2) the presence of pedunculated polyps confirmed by colonoscopy; and (3) the removal of pedunculated polyps through prophylactic clipping, EMR, or ESD techniques. The exclusion criteria were as follows: (1) nonpedunculated polyps; (2) known bleeding disorders; (3) the use of anticoagulant or antiplatelet therapy that could not be discontinued; (4) the presence of multiple pedunculated polyps and the use of various surgical methods for their removal; and (5) incomplete medical records or follow-up data. All patients discontinued anticoagulants and antiplatelet drugs at least 1 week before endoscopy, and resumed them 48 hours postsurgery if necessary. All patients underwent preoperative blood tests, including complete blood count, prothrombin time, and partial thromboplastin time. A total of 195 patients met the inclusion criteria and were included in the final analysis.

Endoscopic Polypectomy

All surgical procedures were conducted through colonoscopes (CV-290, CV-260; Olympus Medical Systems, Tokyo, Japan), snares [Micro-Tech (Nanjing) Co., Ltd.; MTN-PFS-E-15/18], forceps (UPN SFBF, China), hemostatic clips (MD850; Boston Science Resolution CLIP), tissue clips [Micro-Tech (Nanjing) Co., Ltd.; ROCC-D-26-195], and injection needles [Micro-Tech (Nanjing) Co., Ltd., IN02-25423180]. A dual knife (KD-650Q; Olympus, Japan) was used. For bowel preparation, patients are required to consume a standard 3 L polyethylene glycol solution, which is divided into 1 L the night before the procedure and 2 L on the day of the procedure. Following the final dose of bowel cleansing medication, diethyl silicone oil is orally administered to eliminate intestinal foam.

In EMR, a submucosal injection of a mixture of methylene blue and epinephrine (1:100,000) is used to separate the polyp from its base and surrounding tissue, after which a snare is utilized to excise the polyp at its base. The resection site is subsequently closed with titanium clips. Endoscopic submucosal dissection (ESD) involves the injection of a 1:100,000 concentration of methylene blue mixed with adrenaline into the submucosa. A dual knife is subsequently used to create a circumferential incision around the polyp, thereby separating it from the submucosal layer. If large blood vessels or active bleeding are encountered during mucosal dissection, electrocoagulation is performed through hemostatic forceps. Following this procedure, titanium clips are used to close the postoperative wound. During prophylactic clip surgery, clips are applied to the base of the polyp stem, followed by high-frequency ligation of the polyp pedicle, after which electrocoagulation is used to remove the polyp (Fig. 1).

An endoscopic polypectomy was performed, and intraoperative bleeding was managed through electrocoagulation with hemostatic forceps. Postoperative bleeding was initially managed conservatively with fasting, bed rest, and the use of hemostatic medications (tranexamic acid and etamsylate). If conservative treatment failed, endoscopic hemostasis was performed, which included the use of hemostatic clips, electrocoagulation, titanium clips to seal the bleeding wound surface, and adrenaline injections.

Statistical Analysis

All the statistical analyses were performed through statistical software packages such as SPSS (version 26.0; IBM Corp, Armonk, NY). A 2-sided P-value <0.05 was considered statistically significant. The analyzed variables included patient age, sex, polyp size, polyp location, polyp histology, and the type of polyp resection technique used. Categorical variables were compared through the χ^2 test or the Fisher exact test, whereas continuous variables were analyzed through Student t test or one-way analysis of variance (ANOVA).

RESULTS

The Characteristics of Patients and Polyps in Each Group

A total of 195 patients who met the inclusion criteria were enrolled in the study. Among these patients, 132 with pedunculated colorectal polyps were treated with EMR, 46 with colorectal polyps were treated with ESD, and 17 with colorectal polyps were treated with prophylactic clipping. The EMR group had 159 pedunculated polyps, while 47

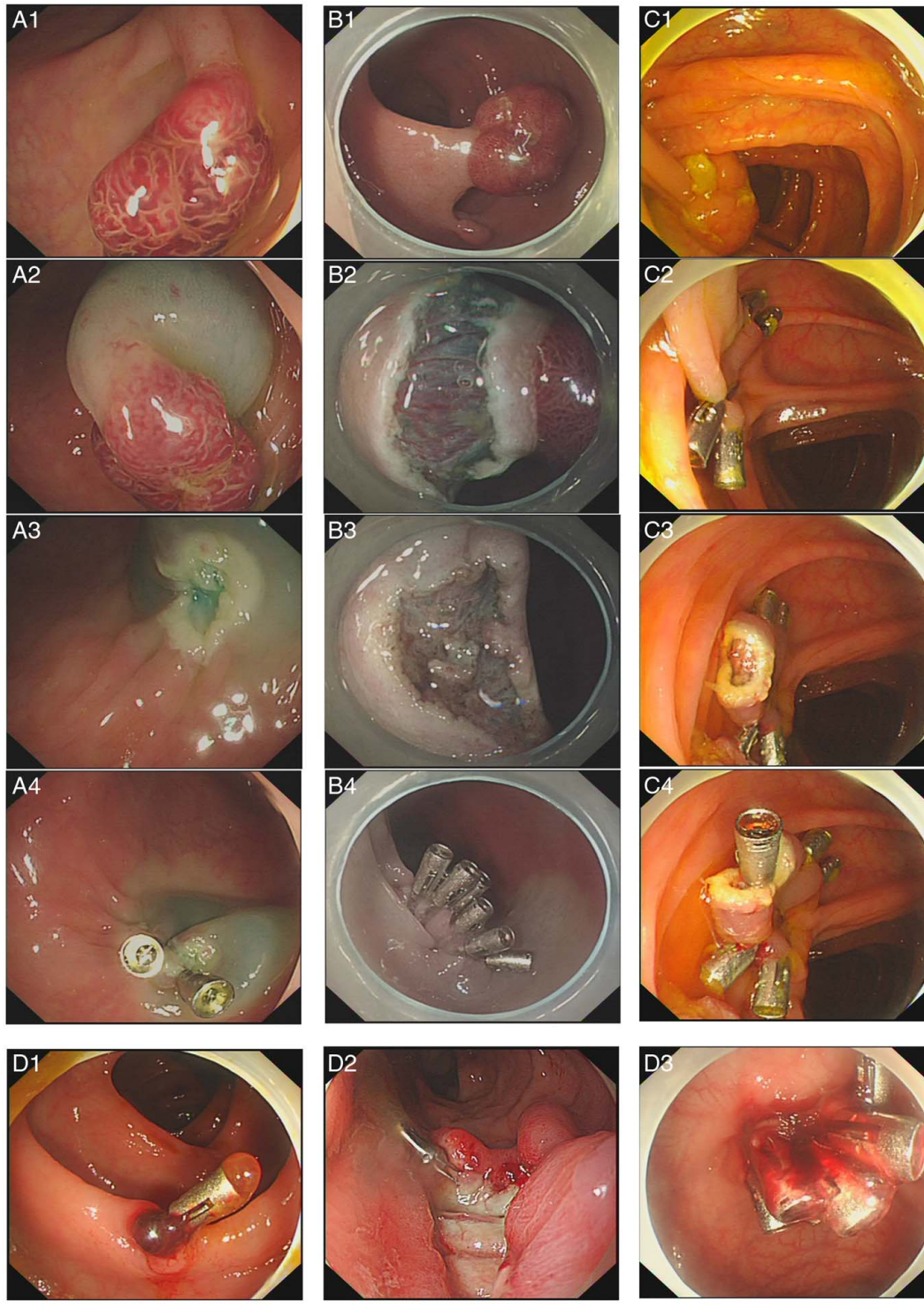

FIGURE 1. EMR, ESD, and prophylactic clips for the removal of pedicled colorectal polyps. (A1–A4) The procedure of endoscopic mucosal resection for the removal of pedunculated colorectal polyps. (B1–B4) The procedure of endoscopic submucosal dissection for the removal of pedunculated colorectal polyps. (C1–C4) The procedure of prophylactic clips for the removal of pedunculated colorectal polyps. (D1) Postoperative bleeding after EMR. (D2) Postoperative bleeding after ESD. (D3) Postoperative bleeding after the administration of prophylactic clips.

polyps were identified in the ESD group, and 21 were identified in the prophylactic clipping group. The average ages of the 3 groups were 57.3 ± 10.4 years in the EMR group, 60.5 ± 10.3 years in the ESD group, and 54.2 ± 16.1 years in the prophylactic clipping group. There were no significant differences in sex, age, or basic diseases, including hypertension, diabetes, and cardiovascular and cerebrovascular diseases, among the 3 groups of patients ($P > 0.05$) (Table 1).

The average sizes of the tips of the pedunculated polyps in the EMR, ESD, and prophylactic clip groups were 1.4 ± 0.6 cm, 2.4 ± 0.6 cm, and 1.8 ± 0.7 cm, respectively. In the EMR and prophylactic clip groups, polyps were concentrated mainly in the range of 1.0 to 1.9 cm, with proportions of 59.7% and 57.1%, respectively. In the ESD group, polyps were predominantly in the range of 2.0 to 2.9 cm. Histologically, there were no significant differences among the 3 groups in terms of low-grade intraepithelial neoplasia, early cancer, or other types. However, the proportion of adenoma in the ESD group was lower than that in the other 2 groups, at 6.4%, whereas the proportion of high-grade intraepithelial neoplasia was greater, accounting for 34.0% of cases (Table 1).

Bleeding Complications

There were significant differences in the incidence of delayed bleeding among the EMR, ESD, and prophylactic clip groups ($P < 0.05$, Table 2). The incidence of delayed hemorrhage after EMR resection of pedunculated colorectal polyps was the highest, at 18.9%. In contrast, the incidence rates of delayed bleeding in the ESD and prophylactic clip groups were 4.3% and 5.9%, respectively. However, further analysis revealed no statistically significant difference in delayed hemorrhage between the ESD group and the prophylactic clip group ($P = 0.603$). There were significant differences in intraprocedural bleeding among the 3 surgical procedures ($P < 0.05$, Table 2). The incidence of intraoperative bleeding in the ESD group was the highest among the 3 groups, at 6.5%. However, there were no significant differences in the need for endoscopic hemostasis after delayed bleeding among the 3 groups ($P > 0.05$, Table 2).

DISCUSSION

Compared with other polyps, pedunculated colorectal polyps are easier to remove endoscopically owing to their long pedicle. However, large blood vessels frequently exist within the pedicle of the polyp, increasing the risk of delayed hemorrhage and intraoperative bleeding during endoscopic treatment compared with other polyps.[15] Some studies indicate that the incidence of postoperative bleeding in patients with pedunculated colorectal polyps can reach 12.5%.[16,17] In our study, the postoperative bleeding rate was the highest in the EMR group, reaching 18.9%, but 14 patients stopped bleeding with just bed rest or medication without endoscopic intervention. The proportion of patients who needed endoscopic hemostasis for postoperative bleeding was 8.33%. The overall incidence of postoperative bleeding after the removal of pedunculated colonic polyps through 3 different methods (EMR, ESD, and prophylactic clipping) was 14.4%, which is slightly higher than the 12.5% reported in previous studies.[16] These data indicate that there is a high risk of postoperative hemorrhage when pedunculated colorectal polyps are treated with endoscopy; thus, researchers have been seeking an effective method to manage pedunculated colorectal polyps. In the guidelines for endoscopic polyp resection published by the European Digestive Endoscopy Association in 2017, cold snare resection was recommended for small polyps (≤ 5 mm), whereas hot snare resection was recommended for large polyps (10 to 19 mm). For small, stemless polyps (6 to 9 mm), both methods were approved according to the guidelines.[11] The 2020 American Gastrointestinal Endoscopy Guidelines recommend that for pedunculated polyps with a head length ≥ 2 cm or a pedicle length ≥ 5 mm, the pedicle should be ligated with nylon loops or metal clips during endoscopic resection to reduce intraoperative and postoperative bleeding.[18] ESD is often applied for the

TABLE 1. Characteristics of Patients and Pedunculated Polyps

	EMR	ESD	prophylactic clips	*P*	χ^2/F
Sex, n (%)				0.067	5.343
Male	83 (62.9)	37 (80.4)	13 (76.5)	—	—
Female	49 (37.1)	9 (19.6)	4 (23.5)	—	—
Age, y					
Mean ± SD	57.3 ± 10.4	60.5 ± 10.3	54.2 ± 16.1	0.093	2.401
Hypertension	42 (31.8)	19 (41.3)	9 (52.9)	0.16	3.708
T2DM	13 (9.8)	3 (6.5)	1 (5.9)	0.917	0.401
Cerebro-cardiovascular disease	7 (5.3)	1 (5.8)	1 (5.5)	0.639	0.925
Polyp number	159	47	21	—	—
Polyp size (cm)					
Mean ± SD	1.4 ± 0.6	2.4 ± 0.6	1.8 ± 0.7	< 0.01	52.247
< 1.0	34 (21.4)	0	0	—	—
1.0-1.9	95 (59.7)	9 (19.1)	12 (57.1)	—	—
2-2.9	23 (14.5)	27 (57.4)	6 (28.6)	—	—
> 3	7 (4.4)	11 (23.4)	3 (14.3)	—	—
Histopathology					
Adenoma	40 (25.2)	3 (6.4)	4 (19.0)	0.012	8.579
Low-grade intraepithelial neoplasia	79 (49.7)	24 (51.1)	10 (47.6)	1.000	0.104
High-grade intraepithelial neoplasia	16 (10.1)	16 (34.0)	2 (9.5)	0.001	14.365
Cancer	1 (0.6)	1 (2.1)	0	0.510	1.733
Other	23 (14.5)	3 (6.4)	5 (23.8)	0.140	4.089

EMR indicates endoscopic mucosal resection; ESD, endoscopic submucosal dissection.

TABLE 2. Bleeding Outcomes Following EMR, ESD, and Prophylactic Clip Treatments

	EMR	ESD	prophylactic clips	*P*	χ^2
Delayed bleeding				0.028	6.852
DB	25 (18.9)	2 (4.3)	1 (5.9)	—	—
Non-DB	107 (89.3)	44 (95.7)	16 (94.1)	—	—
Intraprocedural bleeding	0	3 (6.5)	0	0.018	7.2
Endoscopic hemostasis of delayed bleeding	11 (44.0)	1 (50.0)	1 (100)	0.722	1.397

EMR indicates endoscopic mucosal resection; ESD, endoscopic submucosal dissection.

resection of flat colon lesions with a length-diameter ratio of ≥2 cm, such as laterally spreading tumors. For some giant pedunculated colon polyps, especially when there are risks such as endoscopic segmental resection, submucosal invasion, and bleeding, ESD is considered safer and more effective.[19]

A randomized controlled study revealed that cold snare polypectomy (CSP) was used to remove <10 mm pedunculated colorectal polyps, and there was no delayed hemorrhage in 192 patients. The lower risk of delayed hemorrhage after CSP is due mainly to less damage to the submucosa and muscularis propria, which contain large blood vessels. The lack of delayed injury caused by high-frequency electrocoagulation is also the reason for the low rate of delayed hemorrhage after CSP.[20,21] However, the incidence of intraoperative bleeding was 10.8%, which was significantly greater than the 3.2% reported in the hot snare polypectomy (HSP) group.[22] The incidence of postoperative delayed hemorrhage and intraoperative hemorrhage during endoscopic endoloop combined with hemostatic clip resection of pedunculated colorectal polyps is lower than that of simple adrenaline injection at the base of the stalk.[16]

Our research revealed that the incidence of delayed hemorrhage with ESD and prophylactic clips for removing colorectal pedunculated polyps was significantly lower than the 18.9% reported with EMR. Although the incidence of delayed hemorrhage after ESD was lower in the prophylactic clip group, there was no significant difference between the incidence of delayed hemorrhage with ESD (4.3%) and that with prophylactic clips (5.9%). These data are similar to the 5.1% to 5.9% reported by Jeong-Seon Ji and Luigiano C.[23,24] Prophylactic clips are applied to the base of pedunculated polyps with titanium clips before resection. Prophylactic clip surgery involves the use of titanium clips to clamp the base of a pedunculated polyp before its resection. The principle of preventing bleeding is similar to that of the endoloop procedure, which involves tightening at the base of the pedunculated polyps to effectively block blood flow, thereby preventing bleeding during and after the operation.[25,26] A randomized multicenter study suggested that prophylactic clips and endoloops are equally effective in preventing postoperative bleeding during endoscopic resection of pedunculated colorectal polyps (bleeding rates of 5.1% vs. 5.7%).[23] However, with endoloops, thin pedunculated polyp stalks can be cut off easily. In a narrow intestinal cavity, it is difficult to open the endoloop in a limited space, and it is also challenging to cover the larger head of a pedunculated polyp. However, prophylactic clips also have drawbacks. When the stalk of the polyp is relatively thick, there is a risk of the clips falling off, requiring the use of more clips. The polyp stalk is short, and may leak electricity to the clip, leading to increased tissue damage, followed by perforation and the risk of clip detachment. Leakage of electricity into the clips can lead to increased tissue damage, resulting in perforation and the risk of clips falling off.

Endoscopic submucosal dissection (ESD) is commonly used for the removal of colorectal polyps with laterally spreading tumors exceeding 2 cm in diameter. Previous studies have documented the application of ESD for the removal of pedunculated colorectal polyps;[26–29] however, it has predominantly been utilized for large, thick-stalked polyps, with limited cases reported. Consequently, substantial clinical data are still needed to validate the safety of ESD in the removal of pedunculated colorectal polyps. Choi et al[27] compared the safety and efficacy of ESD versus snare polypectomy for pedunculated colorectal polyps and reported postoperative bleeding rates of 1/23 (4.3%) for the ESD group and 3/20 (15%) for the snare group. The results for the ESD group were similar to our data, whereas the results for the snare group were greater than ours. However, Choi et al[27] study exclusively included polyps >3 cm in diameter. Ma et al[28] utilized an insulated tip to excise intestinal polyps >3 cm in diameter and observed no postoperative bleeding or perforation in 7 patients. Similarly, Yang et al[29] used ESD to remove intestinal polyps >2 cm in 9 patients, reporting postoperative bleeding and perforation rates of 0%. The risk of postoperative bleeding is elevated in pedunculated polyps due to the presence of larger blood vessels at their base. Dobrowolski et al[15] reported a positive correlation between the number of blood vessels at the base of pedunculated polyps and the diameter of the stalk. Therefore, effectively occluding the blood supply at the base of pedunculated polyps can mitigate the risk of postoperative bleeding. ESD involves submucosal dissection, which allows direct visualization of the blood vessels at the base of the polyp (as shown in Fig. 1 B2), and hemostasis can be adequately achieved through electrocoagulation. For small vessels, coagulating and cutting methods can be used, whereas for larger nourishing vessels, thermal biopsy forceps can be used for thorough electrocoagulation, effectively reducing postoperative bleeding. Therefore, ESD offers certain advantages in preventing delayed postoperative bleeding of pedunculated polyps. However, the overall cost of ESD is high, the procedure is complex, and endoscopists using ESD require a significant amount of training for surgeons. Prophylactic clips are easy to use; however, for polyps with thicker stalks, additional or longer clips are necessary to complete the procedure.

In the present study, pedunculated polyps with heads <20 mm were removed through EMR, because it was difficult for the snare to be inserted into the root of polyps >20 mm. This study also revealed that the incidence of delayed postoperative bleeding after EMR removal of pedunculated colorectal polyps was 18.9%, which was significantly greater than that of the ESD group and the prophylactic clip group. The higher incidence of

postoperative bleeding in the EMR group may be due to the fact that the electrocautery snare cuts through more blood vessels in pedunculated polyps, potentially leading to insufficient coagulation of the severed vessels.[27] During EMR, diluted adrenaline is injected into the base of the polyp to reduce blood flow, promote vasoconstriction, and compress blood vessels, thereby minimizing bleeding. This practice is widely accepted.[17,30] However, a retrospective analysis by Tagawa et al[8] involving 1147 patients revealed that injection at the base was a risk factor for postoperative bleeding. They hypothesized that the possible reason was that the injection of saline at the base reduced tissue resistance, resulting in insufficient coagulation during cutting, which led to postoperative bleeding. In the present study, pedunculated polyps with heads <20 mm were removed through EMR, because it was difficult for the snare to be inserted into the root of the polyps >20 mm. Although the polyps in the EMR group were smaller, the postoperative bleeding rate was still high, whereas it was lower in the ESD group. These data indicate that, in terms of postoperative bleeding, EMR is not suitable for use in pedunculated polyps. However, EMR technology is simple and time-saving. Therefore whether EMR is suitable for pedunculated polyps with smaller heads and thinner stalks requires further investigation. This question was not addressed in the current study.

Our data indicate that the intraoperative bleeding rate in the ESD group was greater than that in the other 2 groups; however, all instances were successfully managed through the use of hemostatic forceps and electrocautery during surgery. Among patients with delayed postoperative bleeding, the proportion requiring endoscopic hemostasis did not differ among the 3 groups, with an overall endoscopic hemostasis rate of 46.43%. In summary, for pedunculated polyps, once delayed postoperative bleeding occurs, there is an ~50% chance that endoscopic hemostasis will be necessary. Therefore, reducing delayed postoperative bleeding is key.

This study has certain limitations, as it is a retrospective single-center study. The number of patients in the ESD group and the prophylactic clip group was relatively small. There were differences in polyp size among the 3 surgical methods, the polyps in the EMR group were smaller than those in the other groups, whereas the polyps in the ESD group were larger. In addition, this study analyzed only the correlation between postoperative bleeding and surgery, without addressing the associated complications or other risk factors for postoperative bleeding. However, a study examining the prophylactic use of hemostatic clips to close the base before pedunculated polyps are resected revealed that the diameter and length of the polyp stalk, as well as the polyp location and size, are not risk factors for postoperative bleeding. Rather, the absence of preventive measures is identified as the sole risk factor for postoperative bleeding.[31] Therefore, in future work, more randomized controlled and multicenter studies are needed, as well as evidence to determine which types of pedunculated polyps are suitable for EMR, ESD, or prophylactic clips.

In conclusion, employing endoscopic submucosal dissection (ESD) and clamping the stalk of pedunculated polyps before removal can effectively reduce the risk of postpolypectomy bleeding. Furthermore, ESD offers distinct advantages in removing pedunculated polyps >2 cm or with thicker roots. However, more randomized controlled trials are needed to determine whether the diameter of the head and root polyps is more suitable for ESD and clipping.

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