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Milligan–Morgan hemorrhoidectomy combined with rubber band ligation and polidocanol foam sclerotherapy for the management of grade III/IV hemorrhoids: a retrospective study

Qing Long[1], Yong Wen[1] and Jun Li[1*]

Abstract

Background Hemorrhoids are one of the most common and annoying benign diseases in the field of colorectal surgery. A Milligan–Morgan hemorrhoidectomy (MMH) is the most frequently applied surgical technique due to its clear efficacy and high success rate, but the reported postoperative complications remain a major problem. This study aimed to retrospectively evaluate the efficacy and safety of a MMH combined with rubber band ligation and polidocanol foam sclerotherapy (MMH + RBL + PFS) for the management of grade III/IV hemorrhoids.

Methods This was a single-center retrospective study. A total of 255 patients with grade III/IV hemorrhoids who underwent MMH + RBL + PFS ($n = 128$) or MMH ($n = 127$) between May 2022 and June 2023 were included in the study. The primary outcomes included recurrence rates, hemorrhoid severity score (HSS), and patient satisfaction 12 months after surgery. Secondary outcomes included intraoperative outcomes and postoperative outcomes.

Results Follow-up was conducted by telephone or outpatient visit 12 months after surgery. The recurrence rate was lower in the MMH + RBL + PFS group than in the MMH group ($p < 0.05$). The patient satisfaction score was higher in the MMH + RBL + PFS group than in the MMH group ($p < 0.05$), and there was no significant difference in the HSS between the two groups ($p > 0.05$). The median operation time in the two groups was similar (16 min (15–20 min) vs.16 min (15–18 min), $p > 0.05$). The median number of incisions in the the MMH + RBL + PFS group was 3 (2–3), while that in the MMH group was 3 (3–4) ($p < 0.05$). There was no significant difference in intraoperative blood loss between the two groups ($p > 0.05$). Visual analog scale pain scores were lower in the MMH + RBL + PFS group than in the MMH group at the first postoperative defecation at 12 h and at 1, 3, and 7 days (all $p < 0.05$). The wound healing time was shorter in the MMH + RBL + PFS group than in the MMH group (27.62 ± 3.74 vs. 28.73 ± 4.48 days, respectively, $p < 0.05$). The incidence of urinary retention was lower in the MMH + RBL + PFS group than in the MMH group (5.47% vs. 12.60, respectively, $p < 0.05$). Nine patients (one case in the MMH + RBL + PFS group and eight cases in the MMH group

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($p < 0.05$)) had delayed bleeding and were successfully controlled with manual compression or surgical hemostasis. No cases had anal stenosis in the MMH + RBL + PFS group, and six cases (4.72%) had it in the MMH group, all with mild anal stenosis and successfully treated by dilatation alone ($p < 0.01$). No incision infection or anal incontinence occurred in either group. At the 12-month follow-up after surgery, the recurrence rate was lower in the MMH + RBL + PFS group (0.78%) than in the MMH group (7.09%) ($p < 0.05$). The patient satisfaction score was higher in the MMH + RBL + PFS group (91.41%) than in the MMH group (81.10%) ($p < 0.05$), and there was no significant difference in the HSS between the two groups ($p > 0.05$).

Conclusions Compared with the MMH, the MMH + RBL + PFS surgical procedure is safe and effective for grade III/IV hemorrhoids, which is associated with a lower recurrence rate, a higher patient satisfaction score, a lower postoperative pain score, fewer postoperative complications, and a shorter wound healing time.

Keywords Milligan–Morgan hemorrhoidectomy (MMH), Rubber band ligation, Polidocanol foam sclerotherapy, Hemorrhoids, Postoperative complications

Background

Hemorrhoids, defined as symptomatic enlargement and distal displacement of the normal anal cushion [1], are one of the most common and annoying benign diseases in the field of colorectal surgery. According to the published epidemiological survey [2, 3, 4, 5, 6], the estimates of the incidence rate of hemorrhoids vary from 4 to 55%. They affect millions of people around the world and are more common among people who are 45–65 years old. Almost half of Americans over the age of 50 have experienced symptomatic hemorrhoids [7], while a Chinese survey showed that the overall prevalence of hemorrhoids was 40.27%, which was higher in women (46.22%) than in men (32.30%) [8]. Therefore, hemorrhoids are considered a major medical and socioeconomic problem with a significant impact on the patient's lifestyle [1]. The etiology and pathophysiology of hemorrhoids are still controversial, involving multiple factors, such as enlargement of vascular components, disruption of stromal scaffolding, elevated anal pressure, local inflammation, and rectal redundancy [9]. The weakening of the anal pad and its supporting tissue and the spasm of the internal sphincter are the leading causes of hemorrhoids [10]. At the same time, alcohol consumption, lack of regular physical activity, a sedentary lifestyle, wrong feces discharge habits, constipation, and being overweight are the risk factors for hemorrhoids [11, 12, 13, 14].

The most widely used classification of hemorrhoids is the Goligher classification [15], and treatment options include basic treatment, outpatient procedures, and surgical treatment [16], depending primarily on the severity of the hemorrhoids [17]. Banding and sclerotherapy are commonly used clinic-based procedures and are primarily applicable to patients with grade I and II and selective patients with grade III internal hemorrhoidal disease who fail medical treatment [18]. Rubber band ligation (RBL) is the most popular and effective treatment in clinic-based procedures, as it causes ischemia and necrosis of prolapsed mucosa after ligating hemorrhoid tissue and then forms scar fixation on the rectal wall [19]. This technique is ligated above the dentate line, without somatic nerve branches, and causes less pain. Sclerotherapy leads to inflammation and fibrosis of the hemorrhoid tissue with scarring, followed by mucosal fixation in the submucosa [16, 20–21]. Polidocanol has recently started to be employed in the treatment of hemorrhoids in liquid or foam form and is associated with lower bleeding rates and post-procedural pain [22, 23, 24]. These procedures are all relatively well tolerated, with high patient satisfaction and less pain and discomfort, but they all have a certain recurrence rate and may require repeated applications [25–26]. Hemorrhoidectomy is the gold standard and first choice in surgical therapy for patients with grade III/IV hemorrhoids [27–28], and a Milligan–Morgan hemorrhoidectomy (MMH) is one of the most commonly used surgical techniques because of its evident efficacy and high success rate [29]. However, it is often associated with complications, such as postoperative pain, delayed bleeding, and delayed wound healing [30, 31, 32]. Therefore, none of the surgical methods currently used could be considered a completely painless and safe ideal surgical option. Pata F et al. [33] reported sclerobanding (combining RBL with 3% polidocanol foam sclerotherapy) to treat second–and third–degree hemorrhoids, and indicating that sclerbanding was a safe technique with a low rate of postoperative complications. However, high-grade hemorrhoids (especially grade IV) are often accompanied by external hemorrhoids, this technique may not be applicable, and hemorrhoidectomy is recommended [27–28].

Our previous study have demonstrated that Milligan–Morgan hemorrhoidectomy combined with non–doppler hemorrhoidal artery ligation was effective for treating grade III/IV hemorrhoids [34]. To further reduce the occurrence of postoperative complications, such as postoperative pain and delayed bleeding after MMH, we adopted a new combined procedure of MMH combined with rubber band ligation and polidocanol foam

sclerotherapy (MMH + RBL + PFS). The new combined procedure was less invasive, with PFS could locally achieve sclerotic hemostasis and anesthesia, while RBL could fix the mucous membrane and lift the anal cushion, overcoming some limitations of MMH. Therefore, this study aimed to retrospectively compare and analyze the efficacy and safety of these two procedures.

Materials and methods

Patients

This was a single-center retrospective cohort study and was approved by the Ethics Committee of the Affiliated Hospital of Southwest Medical University, China. A total of 255 patients with grade III/IV hemorrhoids who underwent MMH + RBL + PFS ($n = 128$) or MMH ($n = 127$) in our hospital between May 2022 and June 2023 were retrospectively analyzed (Fig. 1). Senior anorectal surgeons performed all surgical procedures. Informed consent was obtained from all the patients. The inclusion criteria of this study included the following: (1) met the criteria of grade III/IV hemorrhoids according to Goligher's classification; (2) MMH + RBL + PFS or MMH was performed; and (3) age 18–65 years old, regardless of gender. The exclusion criteria included the following: (1) diagnosis of other anorectal diseases, such as anal fistula, perianal abscess, anal fissure, inflammatory bowel disease, and colorectal malignant tumors; (2) diagnosis of systemic diseases, such as hypertension, diabetes, liver and kidney insufficiency, and abnormal coagulation function; (3) history of anal surgery; (4) patients with significantly increased abdominal pressure diseases, such as severe prostatic hyperplasia and intractable constipation; (5) women who are breastfeeding or pregnant; and (6) patients who are allergic to polidocanol injection.

Data collection

All demographic and clinical characteristics saved in the database after operations were collected retrospectively. The primary outcomes included recurrence rates, hemorrhoid severity score (HSS), and patient satisfaction 12 months after surgery. Secondary outcomes included intraoperative outcomes and postoperative outcomes. Intraoperative outcomes included operative time, number of incisions, and intraoperative blood loss. Postoperative outcomes included postoperative pain, urinary retention, wound healing time, delayed bleeding, wound infection, and long-term postoperative complications, including anal stenosis and anal incontinence. Recurrence was defined as prolapse or bleeding after symptom improvement. The HSS was used to record the frequency (0 = never; 1 = less than once a week; 2 = one to six times a week; and 3 = daily or always) of five self-reported symptoms of hemorrhoids (pain from the hemorrhoids, itching or discomfort of the anus, bleeding, soiling, and

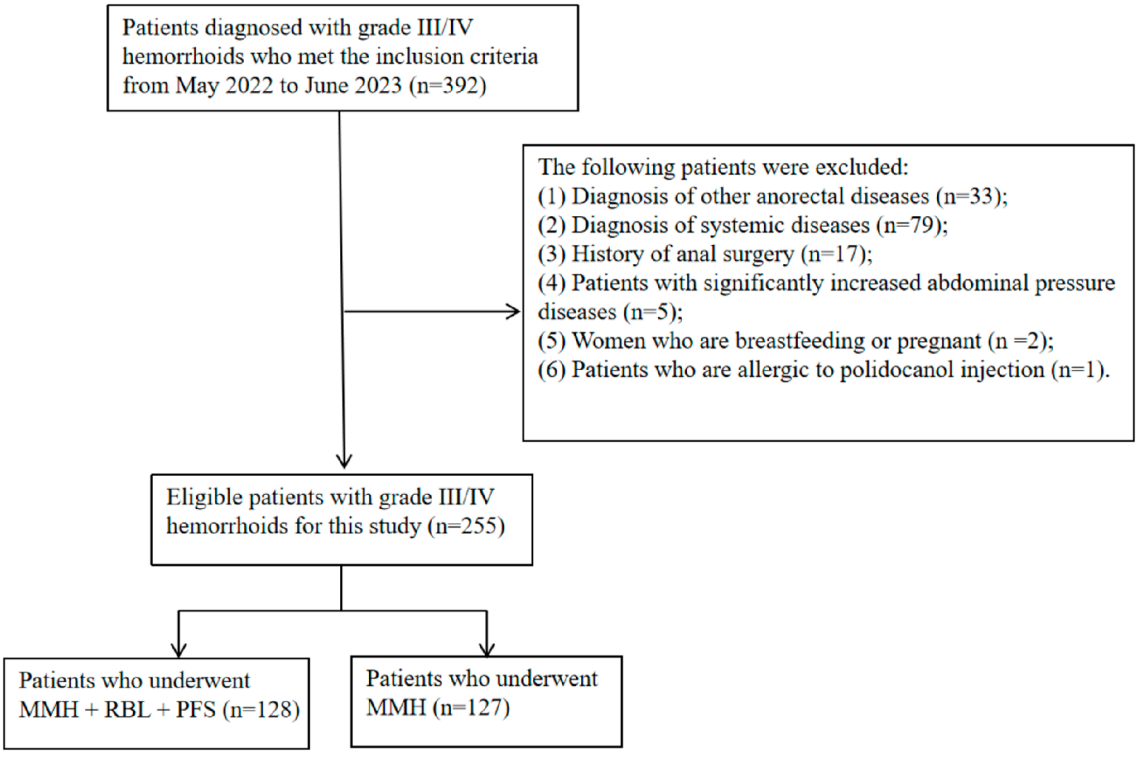

Fig. 1 Flow chart of the study design. MMH + RBL + PFS: Milligan-Morgan hemorrhoidectomy combined with rubber band ligation and polidocanol foam sclerotherapy, MMH: Milligan-Morgan hemorrhoidectomy

prolapse on defecation requiring manual reduction) from the patient questionnaire, with a maximum score of 15 points [35]. The visual analog scale (VAS) score was used to evaluate the postoperative pain (range: 0–10 points, where 0 = no pain and 10 = worst possible pain) [36]. The VAS scores were recorded postoperatively at 12 h; at 1, 3, and 7 days; and at the first postoperative defecation. A five-point Likert scale was used to assess patient satisfaction with the conducted treatment (0 = strongly satisfied; 1 = somewhat satisfied; 2 = neutral; 3 = somewhat dissatisfied; and 4 = strongly dissatisfied). Anal stenosis was classified into three groups: mild, moderate, and severe, based on anal examination with the small-index finger or medium-small Hill–Ferguson retractor [37], according to the classification of Milsom and Mazier. The occurrence of anal incontinence was classified as gas, liquid, or solid fecal incontinence. Patients were followed up weekly at the outpatient clinic until the wound healed completely(data collected included pain, urinary retention, wound healing time, delayed bleeding, wound infection, anal stenosis and anal incontinence, etc.). At the 12-month after surgery, follow-up was conducted via telephone or outpatient clinic visit to evaluate recurrence, HSS and satisfaction. Patients who could not be reached by their provided telephone number were considered lost to follow-up.

Surgical procedures

All patients had spinal anesthesia and MMH or MMH + RBL + PFS was performed in the lithotomy position.

MMH Procedure. The MMH was performed according to the standard technique described by Milligan and Morgan [38]. After careful anal dilation, a V-shaped incision was made in the skin of the anus. The pedicle of each hemorrhoid was then dissected up to the dentate line and ligated. The incisions were left open and at least 8 to 10 mm of anal mucosa and skin should be left intact between the incisions. The procedure was performed with a fine needle-type electric knife, and hemostatic treatment was used via electric coagulation.

MMH + RBL + PFS procedure. The MMH + RBL + PFS procedure was performed as follows: (1) After disinfecting the perianal skin and rectum, a careful anal dilation was performed (Fig. 2A). (2) An anal speculum was inserted to assess the distribution of hemorrhoids and the rectal mucosa above them, in order to determine the ligation points and the number of ligations. The negative pressure suction joint of the ligation device was connected to the external negative pressure suction system. Under the exposure of the anal speculum, the ligation device barrel was aimed at the internal hemorrhoid and loose mucosa, and it was sucked into the ligation tube under negative pressure suction. When the negative pressure reached − 0.08 to − 0.1 MPa, the ratchet wheel was turned to release the elastic suture ring. The negative pressure release switch was turned on while tightening the elastic suture ring. The lapped tissue was released, and the excess elastic wire was cut off (leaving a length of 4–5 mm) (Fig. 2B). Then, two to three hemorrhoids were ligated in the same way. In addition, a certain distance between the suction barrel and the intestinal wall was maintained to avoid fistulas (especially the anterior side of the female anal canal and rectum) and to avoid ligation at the same level to prevent rectal stenosis. (3) Then, 1–2 mL of 1% polidocanol foam (using a three-way valve to connect two 10-mL silicon-free syringes, in which one syringe extracts 2 mL of 1% polidocanol, and the other syringe extracts 8 mL of air, pushing the injection back and forth 10 times and causing the air to mix with the hardener to make the foam harden) was injected into each of the nodules of the ligate (Fig. 2C). (4) Residual hemorrhoids were excised by MMH, and 1% polidocanol foam was also injected into the ligated nodules (Fig. 2D).

Postoperative management

After the operation, the patients rested in a supine position for 6 h, had a normal diet, received intravenous antibiotics (cefuroxime) for 24 h to prevent infection, took a warm water sitz bath (38–42 °C) for 15 min after defecation, and had their dressing changed once a day. When the pain was intolerable, patients were given oral or intramuscular painkillers.

Statistical analysis

The statistical analyses were performed using SPSS version 25.0 (SPSS Inc., Chicago, IL, USA). Continuous variables are expressed as means ± standard deviations or medians with interquartile range (IQR), and the *t*-test was performed. We analyzed categorical variables using the Pearson chi-square test or Fisher's exact test. The data were regarded as statistically significant when $P < 0.05$.

Result

Patient characteristics

A total of 255 patients were enrolled, comprising 128 patients who underwent MMH + RBL + PFS and 127 who underwent MMH. There were no significant differences in age, sex, disease duration, hemorrhoid grade, or HSS between the two groups at baseline ($p > 0.05$), as shown in Table 1. No cases were lost during the follow-up period.

Intraoperative outcomes

The median operative time in the MMH + RBL + PFS group was 16 min (15–20 min), while that in the MMH group was 16 min (15–18 min) ($p > 0.05$). The median number of incisions in the MMH + RBL + PFS group was 3 (2–3), while that in the MMH group was 3 (3–4)

Fig. 2 (**A**) Patient was placed in the lithotomy position, and the distribution of hemorrhoids was observed after anesthesia. (**B**) Ligating the internal hemorrhoid and loose mucosa (**C**) and injecting polidocanol foam into each of the ligated nodules. (**D**) MMH was performed with a fine needle-type electric knife, while hemostatic treatment was used via electric coagulation

Table 1 Patient characteristics

Group	MMH + RBL + PSF (*n* = 128)	MMH (*n* = 127)	t/χ^2 value	*P* value
Age (years)	47 (38, 56)	46 (38, 54)	0.902	0.368
Sex (male/female)	75/53	81/46	0.722	0.396
Disease duration (years)	7 (4, 14)	5 (4, 11)	0.797	0.426
Grade of hemorrhoids (III/IV)	102/24	98/29	0.646	0.422
Hemorrhoid severity score (HSS)	8 (7, 9)	7 (7, 9)	0.268	0.789

Note: Age, sex, disease duration, and HSS are presented as the medians with the interquartile range (IQR)

($p < 0.05$). There was no significant difference in intraoperative blood loss between the two groups ($p > 0.05$), as shown in Table 2.

Postoperative outcomes and complications

The VAS pain scores were lower in the MMH + RBL + PFS group than in the MMH group at the first postoperative defecation at 12 h and at 1, 3, and 7 days (all $p < 0.05$). The wound healing time was shorter in the MMH + RBL + PFS group than in the MMH group (27.62 ± 3.74 vs. 28.73 ± 4.48 days, respectively, $p < 0.05$). The incidence of urinary retention was lower in the MMH + RBL + PFS group than in the MMH group (5.47% vs. 12.60, $p < 0.05$). Nine patients (one case in the MMH + RBL + PFS group

Table 2 Intraoperative outcomes

Group	MMH + RBL + PSF (*n* = 128)	MMH (*n* = 127)	t/χ^2 value	*P* value
Operative time (min)	16 (15, 20)	16 (15, 18)	1.867	0.063
Number of incisions	3 (2, 3)	3 (3, 4)	−10.076	< 0.001
Intraoperative blood loss (mL)	5 (2, 5)	5 (3, 5)	−1.600	0.111

Note: The operative time, number of incisions, and intraoperative blood loss are presented as medians with the interquartile range (IQR)

Table 3 Postoperative outcomes and complications

Group	MMH + RBL + PSF (*n* = 128)	MMH (*n* = 127)	t/χ^2 value	*P* value
Visual analog scale (VAS) pain score				
First postoperative defecation	5 (4, 5)	5 (4, 6)	−2.203	0.028
12 h	4 (3, 5)	4 (4, 5)	−3.355	0.001
1 day	3 (2, 3)	3 (3, 4)	−3.209	0.002
3 days	2 (2, 3)	3 (2, 3)	−2.611	0.010
7 days	2 (1, 2)	2 (1, 3)	−3.064	0.002
Wound healing time (day)	27.62 ± 3.74	28.73 ± 4.48	−2.160	0.023
Urinary retention	7 (5.47%)	16 (12.60%)	3.949	0.047
Delayed bleeding	1	8 (6.30%)	4.195	0.041
Wound infections	0	0	-	-
Anal stenosis				
Mild	0	6 (4.72%)	4.307	0.038
Moderate	0	0		
Severe	0	0		
Anal incontinence	0	0	-	-

Note: The visual analog scale (VAS) pain scores are presented as medians with the interquartile range (IQR); wound healing times (day) are presented as the means ± standard deviations; and urinary retention, delayed bleeding, wound infections, anal stenosis, and anal incontinence are presented as N (percentage)

Table 4 Recurrence, hemorrhoid severity score (HSS), and patient satisfaction 12 months after surgery

Group	MMH + RBL + PSF (*n* = 128)	MMH (*n* = 127)	t/χ^2 value	*P* value
Recurrence	1 (0.78%)	9 (7.09%)	5.157	0.023
HSS	0 (0, 1)	0 (0, 1)	−1.290	0.198
Patient satisfaction	117 (91.41%)	103 (81.10%)	5.716	0.017

Note: Recurrence and patient satisfaction are presented as N (percentage); HSS is presented as medians with the interquartile range (IQR)

and eight cases in the MMH group ($p < 0.05$)) had delayed bleeding and were successfully controlled with manual compression or surgical hemostasis. No cases had anal stenosis in the MMH + RBL + PFS group, and there were six cases in the MMH group, all with mild anal stenosis and who were successfully treated with dilatation alone ($p < 0.01$). No incision infection or anal incontinence occurred in either group, as shown in Table 3.

Recurrence, HSS, and patient satisfaction 12 months after surgery

At the 12-month follow-up after surgery, the recurrence rate was lower in the MMH + RBL + PFS group (0.78%) than in the MMH group (7.09%) ($p < 0.05$). The patient satisfaction score was higher in the MMH + RBL + PFS group (91.41%) than in the MMH group (81.10%) ($p < 0.05$), and there was no significant difference in the HSS between the two groups ($p > 0.05$), as shown in Table 4.

Discussion

A conservative approach is typically used at the initial stage of hemorrhoids, which includes toilet training, high-fiber nutrition, and topical and pharmacological treatments (e.g., laxatives, venotropics, nonsteroidal anti-inflammatory drugs, and non-opioid analgesics) [16, 27]. When conservative treatment fails, interventional treatment methods are used. Grade III and IV hemorrhoids are a more serious anal and rectal disease in the later stage of hemorrhoid development, accompanied mainly by external hemorrhoids (skin tags) forming mixed hemorrhoids, which have a significant impact on the patient's life and work. When conservative treatment is ineffective, they generally require surgical treatment.

Currently, there are numerous surgical procedures for hemorrhoids, including hemorrhoidectomy, stapled hemorrhoidectomy, and Doppler-guided hemorrhoid art alignment (DG-HAL)/transanal hemorrhoid dearterialization (THD). Among them, hemorrhoidectomy is the most widely used and recommended surgical technique for grade III and IV hemorrhoids by the guidelines from multiple countries [19, 27, 29, 39]. The aim of hemorrhoidectomy is to ligate the vascular pedicles and excise the enlarged hemorrhoidal tissue both above and below the dentate line. Depending on the surgical wound treatment techniques, the most famous representative surgical methods are open hemorrhoidectomy (Milligan–Morgan procedure) and closed hemorrhoidectomy (Ferguson procedure) [27, 29]. MMH is a surgical procedure based on the theory of "varicose veins" with definite efficacy, especially for high-grade hemorrhoids (grade III/IV), which has been confirmed by numerous randomized controlled trials and systematic reviews [40–41]. Although DG-HAL/THD is minimally invasive and can reduce postoperative pain, bleeding, and complications, the long-term recurrence rate may be very high [42, 43, 44]. Altomare DF et al. [45] evaluated the changes in the treatment of 32,458 hemorrhoid patients in Italy over the last 17 years and found that the proportion of MMH has remained between 65 and 70% and that MMH remains the most frequently performed procedure for grade III hemorrhoids. However, hemorrhoidectomy has some disadvantages, which may be related to early

and late complications, such as postoperative pain, urinary retention, long recovery period, delayed bleeding, anal stenosis, and fecal incontinence [31, 32, 46, 47, 48]. Banding and sclerotherapy are commonly used clinical procedures for the treatment of grade I–II and selective grade III hemorrhoids [18, 49, 50, 51, 52, 53]. RBL has the advantages of being quick, relatively painless, and generally well tolerated due to its application in an area lacking somatic sensitivity (at the base of the hemorrhoids above the dentate line) [49]. However, RBL has shown variable success rates and a considerable risk of recurrence, which may require further intervention. The common complications of RBL technology include pain, bleeding, and thrombosis [26]. Still, there are some rare but serious complications, such as liver abscess, massive secondary rectal hemorrhage, perineal septicemia, and death [54, 55, 56]. Polidocanol, a detergent-type sclerosant and local anesthetic, is one of the emerging sclerosant agents for the treatment of hemorrhoids [22, 57]. The apparent advantage of polidocanol foam is that it increases the proportion of active drugs on endothelial cells, resulting in uniform distribution of drug microbubbles [58], higher adhesion to the endothelium, and greater hardening ability. Moser KH et al. [59] evaluated the efficacy and safety of polidocanol foam compared with liquid polidocanol for the treatment of hemorrhoids, and the results showed that polidocanol foam was more effective than liquid polidocanol and that patients had higher satisfaction with equivalent safety. Polidocanol is well tolerated locally and has a low incidence of systemic reactions [60], but clinicians should know about the possibility of uncommon but life-threatening adverse reactions, such as severe anaphylactic reactions and cardiac arrest [61–62]. Currently, the concentration of polidocanol used for treating hemorrhoids in clinical practice is not standardized, with commonly used concentrations ranging from 1 to 3% [23, 24, 63]. In our study, a low concentration of 1% polidocanol was injected into each ligated nodule to avoid potential side effects and ensure patient safety.

With more minimally invasive surgical concepts being developed, the focus of various surgical procedures for treating hemorrhoids is to maximize the protection of the anal transitional epithelium and the anal cushion tissue. Therefore, we adopted a new combined procedure of MMH with RBL and polidocanol foam sclerotherapy to treat III/IV hemorrhoids to improve the effectiveness and reduce some typical complications of the three treatment methods.

According to our results, the median operation time in the MMH + RBL + PFS group was similar to that in the MMH group ($p > 0.05$), and the median number of incisions was less in the MMH + RBL + PFS group than in the MMH group ($p < 0.05$). These findings demonstrate that the MMH + RBL + PFS procedure could protect part of the anal cushion by ligating hemorrhoids and loose prolapsed mucosa, and the downward moving anal cushion can be moved upward, achieving the purpose of removing hemorrhoid tissue, fixing mucous membrane simultaneously, and correcting prolapse [25]. Internal hemorrhoids can gradually necrotize or be moved upward, while external hemorrhoids may decrease or transform from an unbounded circular shape to a relatively clear boundary, reducing the difficulty of hemorrhoidectomy and decreasing the number and length of incisions. Therefore, there was no significant difference in operation time between the two groups. There was no significant difference in intraoperative bleeding between the two groups, which was related to the use of a fine needle-type electric knife, which effectively reduced intraoperative bleeding.

In this study, the VAS pain score of the MMH + RBL + PFS group at all time points after surgery was lower than that of the MMH group (all $p < 0.05$), and the wound healing time was shorter than that of the MMH group ($p < 0.05$). The result indicated that compared to MMH, MMH + RBL + PFS had better tolerance, mainly due to RBL lifting the anal cushions and reducing the extent of excision to minimize the wound area, while the local anesthetic effect of PFS blocked pain transmission. The study showed that the incidence of delayed bleeding, urinary retention, and anal stenosis was lower in the MMH + RBL + PFS group than in the MMH group (all $p < 0.05$). No incision infection or anal incontinence occurred in either group. Yu Q et al. [64] reported a comparison between the Ruiyun procedure for hemorrhoids combined with simplified Milligan–Morgan hemorrhoidectomy (RPH + sMMH) and MMH, showing that RPH + sMMH could reduce the occurrence of bleeding and anorectal stenosis. This was consistent with our findings, but unlike the above studies, we adopted a new combined procedure of MMH with RBL and polidocanol foam sclerotherapy for treating III/IV hemorrhoids. Notably, we used a fine needle-type electric knife for excising hemorrhoids. The combined procedure of MMH + RBL + PFS could significantly reduce postoperative complications through multiple mechanisms. RBL could ligate internal hemorrhoids or relaxed rectal mucosa, lift the anal cushions, and reduce the extent of resection and the number of incisions, thereby decreasing the risk of bleeding. PFS could further lead to complete occlusion of hemorrhoid blood vessels by injecting polidocanol foam into the ligated nodules, increasing inflammatory response, reducing the occurrence of severe delayed bleeding [33], minimizing anal skin and mucosal damage, and protecting the anal cushion from anal stenosis. Postoperative pain was considered to be one of independent risk factors for urinary retention after anorectal surgery such as hemorrhoidectomy [65]. This combined procedure could reduce postoperative

pain, reduce reflex spasm of pelvic floor muscles, and significantly reduce the risk of urinary retention.

After 12 months of follow-up, the recurrence rate of the MMH + RBL + PFS group was lower than that of the MMH group ($p < 0.05$), and the satisfaction rate was higher than that of the MMH group ($p < 0.05$). There was no significant difference in the HSS between the two groups ($p > 0.05$). These findings demonstrate that MMH + RBL + PFS appears to be a satisfactory surgical procedure for grade III/IV hemorrhoids compared with MMH, and this combined procedure can maximize the advantages, improve the effectiveness, and reduce some typical complications of the three treatment methods. However, future clinical trials will be necessary to confirm this conclusion.

The following are some limitations of the study: it included a small sample size, was a single-center retrospective study, had a short postoperative follow-up time, and had limited results. A multicenter randomized controlled study with larger sample sizes and longer follow-up times is necessary in the future to fully evaluate the safety and efficacy of the MMH + RBL + PFS procedure.

Conclusion

Compared with the MMH, the MMH + RBL + PFS surgical procedure appears to be satisfactory for grade III/IV hemorrhoids, which is associated with a lower recurrence rate, a higher patient satisfaction score, a lower postoperative pain score, fewer postoperative complications, and a shorter wound healing time.

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Author contributions
Long Q and Li J designed the study; Wen Y and Li J collected and analyzed the data; Long Q and Wen Y wrote the draft manuscript. All authors read and approved the final manuscript.

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Data availability
The datasets used during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
The study protocol was approved by the Ethics Committee of the Affiliated Hospital of Southwest Medical University and conducted according to the principles of the Declaration of Helsinki.All methods were performed in accordance with the relevant guidelines and regulations.Written informed consent was obtained from all patients.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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