ORIGINAL ARTICLE

Effect of Doppler-guided Hemorrhoidal Artery Ligation Technique and Mucopexy on Posttreatment Symptoms in Hemorrhoidal Disease

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Background: There is currently no universally accepted gold standard for the surgical treatment of hemorrhoidal disease. This study aimed to assess the efficacy and safety of the Doppler-guided hemorrhoidal artery ligation (DG-HAL) technique, with or without concomitant mucopexy, on postoperative clinical outcomes in patients with symptomatic grade II to IV hemorrhoidal disease.

Patients and Methods: A retrospective analysis was conducted using a prospectively maintained database of patients who underwent DG-HAL ± mucopexy between January 2018 and January 2023 for medically refractory hemorrhoidal disease. Postoperative complications, analgesia type and duration, and time to return to daily activities were recorded. Patients were followed up by a general surgery specialist on postoperative day 1, week 1, month 1, and year 1. Treatment efficacy was evaluated based on changes in symptom severity and hemorrhoid grade across follow-up periods.

Results: A total of 94 patients (59 males, 35 females; mean age: 47.8 ± 12.4 y) underwent the procedure. Recurrence occurred in 9 patients (9.6%) during follow-up. Recurrence rates were 8.16% (4/ 49) in grade III and 31.25% (5/16) in grade IV hemorrhoids. Mean Visual Analogue Scale (VAS) scores for pain were 7.43 (postoperative day 1), 1.72 (week 1), and 0.37 (month 1), demonstrating significant improvement ($P < 0.001$). No postoperative bleeding, necrosis, or urinary retention was reported. One patient experienced early recurrence on the first postoperative day. Overall symptom resolution was achieved in 92.6% of patients, and 90.4% reported high satisfaction with the treatment.

Conclusion: DG-HAL with or without mucopexy is a safe and effective minimally invasive surgical option for grade II and III hemorrhoidal disease, with high patient satisfaction, low complication rates, and excellent symptom resolution. However, in patients with grade IV disease, the technique's higher recurrence rate necessitates careful patient selection and individualized surgical planning.

Key Words: hemorrhoids, doppler-guided hemorrhoidal artery ligation, transanal hemorrhoidal dearterialization, mucopexy, minimally invasive surgery

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Hemorrhoidal disease (HD) is the most prevalent condition in colorectal practice. It refers to the symptomatic enlargement and distal displacement of normal hemorrhoidal tissue, leading to clinical manifestations such as pain, pruritus, rectal bleeding, and, in some cases, fecal incontinence.[1,2] While epidemiological studies report a prevalence of ~4.4%, more than 50% of individuals are estimated to experience hemorrhoid-related symptoms at some point in their lives.[3] Conservative management— including dietary modifications, lifestyle changes, and pharmacological treatment—is recommended for all stages of the disease. However, surgical intervention is often required in advanced stages or in cases presenting with severe and refractory symptoms.[4]

The ideal surgical approach for hemorrhoidal disease should minimize disease-related symptoms and recurrence while reducing postoperative complications and maximizing patient satisfaction.[5] Currently, no single technique fully meets all these criteria. Excisional techniques, such as the Milligan-Morgan and Ferguson hemorrhoidectomies, demonstrate lower recurrence rates; however, they are associated with higher rates of postoperative pain, anal stenosis, and incontinence, particularly when multiple hemorrhoidal columns are excised.[6–8] Conversely, nonexcisional, minimally invasive techniques— including transanal hemorrhoidal dearterialization (THD), Doppler-guided hemorrhoidal artery ligation (DG-HAL), sclerotherapy, laser hemorrhoidoplasty, and aluminum potassium sulfate and tannic acid (ALTA) injection— are associated with less tissue trauma, reduced postoperative discomfort, shorter recovery times, and lower incidences of anal stenosis and incontinence. Nevertheless, these techniques may be associated with higher recurrence rates.[9–11]

In response to the need for less invasive options, Morinaga et al[12] introduced a novel nonexcisional technique in 1995, in which selective ligation of hemorrhoidal arteries was performed under Doppler guidance. Over time, this technique was refined by the addition of mucopexy, a procedure that involves plication of prolapsed mucosal and submucosal tissue to address prolapse—a common symptom of advanced hemorrhoidal disease.[13]

The primary objective of this retrospective single-center study was to evaluate the long-term recurrence rate and patient

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satisfaction associated with DG-HAL, with or without concomitant mucopexy, in patients with symptomatic grade II, III, or IV hemorrhoids. Secondary objectives included assessment of hospital stay duration, postoperative analgesia requirements, and the resolution of key hemorrhoid-related symptoms such as pain, bleeding, prolapse, and incontinence.

PATIENTS AND METHODS Source of Data and Study Population

This study was conducted following approval by the institutional ethics committee (approval no: 78017789/ 050.01.04, dated November 19, 2024). Patients who underwent

Doppler-guided hemorrhoidal artery ligation (DGHAL) ± mucopexy for symptomatic, medically refractory grade 2, 3, or 4 hemorrhoidal disease between January 2018 and January 2023 were included. All patients provided informed consent before the procedure.

Hemorrhoidal disease grading was performed according to Goligher’s classification.[14] Inclusion criteria were patients aged 18 to 85 years with persistent symptoms despite medical and conservative treatment and diagnosis of grade 2 to 4 hemorrhoidal disease. Exclusion criteria included previous surgical or office-based hemorrhoidal interventions, presence of perianal fissure, fistula, anal incontinence, inflammatory bowel disease, and history of anal canal or rectal tumors.

All patients underwent thorough preoperative evaluation including history and physical examination. The degree of hemorrhoidal disease, disease-related symptoms (pain, bleeding, itching, prolapse), and anesthesia type used during surgery were recorded. Postoperative pain was assessed on postoperative day 1, week 1, and month 1 using a patientreported Visual Analog Scale (VAS).[15] Postoperative analgesic requirements (NSAIDs, tramadol), duration, and dosages were extracted from hospital records.

Patient satisfaction postoperatively was classified as satisfied, partially satisfied, or dissatisfied based on patientreported outcomes. Preoperative symptoms were compared with postoperative status and categorized as decreased, unchanged, or increased.

Preoperative Preparation and Hemoroidal Dearterialization-Ligation Technique

On the day of surgery, patients received a single-dose rectal enema for distal rectal clearance. Prophylactic antibiotics were administered as a single dose of cefuroxime 750 mg and metronidazole 500 mg intravenously. General anesthesia was performed for all patients.

Patients were positioned in the lithotomy position. Using a transparent anoscope, the anal canal and distal rectum were

evaluated. Grade 4 hemorrhoidal disease is illustrated in Figure 1. The Doppler system was then activated to detect hemorrhoidal arteries located at the 1, 3, 5, 7, 9, and 11 o’clock positions in a clockwise manner.

The anoscope was then withdrawn to reach ~2 cm proximal to the anorectal junction, and ligation was performed with 2-0 polyglactin sutures. Figures 2 and 3 demonstrate Doppler flow before and after artery ligation. The Angiodin-Procto ultrasonic system, integrating continuous wave (CW), Doppler, and advanced pulsed wave (PW) modes, was used to facilitate precise artery localization and to verify the effectiveness of the ligation procedure.

Mucopexy was performed by reinserting the anoscope and placing a proximal fixation suture in a Z-shaped manner approximately 6 to 7 cm from the anal verge, incorporating the hemorrhoidal tissue without damaging the rectum or submucosa. Mucopexy was routinely performed in grade 4 hemorrhoidal disease due to prolapsed tissue; in grade 2 and 3 patients, it was added only if prolapse was present. The postprocedure appearance of grade 4 hemorrhoidal disease following DG-HAL and mucopexy is shown in Figure 4.

Postoperative Period and Follow-up

Patients were advised to avoid heavy exercise for 30 days after surgery. NSAIDs were prescribed for analgesia, and tramadol was administered as needed. A high-fiber diet and adequate hydration (minimum 2 L/d) were recommended to soften stool and prevent constipation.

FIGURE 1. Preoperative appearance of grade 4 hemorrhoidal disease.

Follow-up visits were scheduled on postoperative day 1, days 7 to 10 after discharge, month 1, and year 1. On day 1 and days 7 to 10, only visual inspection of the anal canal was performed; digital rectal examination or anoscopy was avoided. Dietary recommendations were reinforced.

At the 1-month visit, success was assessed through digital rectal examination and anoscopy. For 1-year followup, patients were contacted through telephone by a general surgery specialist, and symptomatic patients were invited for clinical reevaluation. Recurrence was documented based on clinical findings.

Statistical Methods

Continuous variables were presented as mean ± SD, median, minimum, and maximum values; categorical variables were expressed as counts and percentages.

Student t test was used to compare continuous variables between two independent groups. The χ^2 test evaluated the association between hemorrhoidal disease stage and categorical variables such as bleeding and prolapse status. Repeated-measures ANOVA assessed the mean difference of VAS scores over time, with Bonferroni post hoc tests for pairwise comparisons.

A P-value of <0.05 was considered statistically significant. Data analysis was performed using IBM SPSS Statistics version 25.

FIGURE 2. Flow pattern of the 5 o'clock radial hemorrhoidal artery before ligation.

RESULTS

A total of 94 patients underwent hemorrhoidal artery ligation with mucopexy during the study period. The patients' ages ranged from 24 to 84 years, with a mean age of 47.8 ± 12.4 years and a median age of 45.5 years. Of the patients, 37.2% were females and 62.8% were males. Body mass index (BMI) ranged from 22 to 38, with a mean of 27.1 ± 3.5 and a median of 26. Descriptive statistics regarding patient characteristics are shown in detail in Table 1.

Recurrence was observed in 9 patients (9.6%). Of these, 5 cases (31.25%) were in the stage IV group (n = 16), and 4 cases (8.16%) were in the stage III group (n = 49). The time to recurrence ranged from 1 to 12 months, with a mean of 3.8 ± 2.7 months and a median of 3 months.

The number of arterial ligations performed ranged from 5 to 7, with a mean of 6.1 ± 0.4 and a median of 6. The number of hemorrhoidal subgroups treated ranged from 0 to 4, with a mean of 2.3 ± 1 and a median of 3. The operative time varied between 14 and 44 minutes, with a mean of 25.9 ± 5.8 minutes and a median of 26 minutes.

FIGURE 3. Flow pattern of the 5 o'clock radial hemorrhoidal artery after ligation.

Regarding preoperative anesthetic assessment, the American Society of Anesthesiologists (ASA) classification was as follows: grade I in 37.2% of patients, grade II in 56.4%, and grade III in 6.4%.

Preoperative symptoms included prolapse in 78.7% of patients, bleeding in 67%, and both prolapse and bleeding in 54.3%. Postoperative analgesia consisted of nonsteroidal anti-inflammatory drugs (NSAIDs) in 45.7% of cases and tramadol in 54.3%.

Postoperative patient satisfaction was reported as satisfied in 56.4% of patients, partially satisfied in 34%, and dissatisfied in 9.6%. Symptomatic improvement was achieved in 92.6% of patients, while symptoms remained unchanged or worsened in 7.4%.

No postoperative complications such as fecal incontinence, urinary retention, postoperative bleeding, perianal infection, or hemorrhoidal sac necrosis were observed. One patient experienced early recurrence.

A significant association was identified between hemorrhoidal disease stage and the presence of bleeding, prolapse, and both symptoms (P <0.001 for all). Bleeding

FIGURE 4. Appearance of grade 4 hemorrhoidal disease after DGHAL and mucopexy.

was present in 27.6% of patients with stage II disease, 79.6% with stage III, and 100% with stage IV. Prolapse was present in 51.7% of stage II patients, 87.8% of stage III, and 100% of stage IV. Combined bleeding and prolapse were observed in 3.4% of stage II patients, 69.4% of stage III, and 100% of stage IV. The evaluation of the relationship between bleeding and prolapse with the degree of disease is shown in Table 2.

Postoperative pain was assessed using the Visual Analog Scale (VAS). The mean VAS score was 7.43 ± 1.46 on postoperative day 1, 1.72 ± 1.51 at the end of the first week, and 0.37 ± 0.19 at the end of the first month. The reduction in pain scores over time was statistically significant (P < 0.001), with significant differences observed between each time point (P <0.001 for all comparisons). The evaluation of differences in VAS measurement values over time is shown in Table 3.

DISCUSSION

Hemorrhoidal artery ligation (HAL) is a relatively novel and minimally invasive surgical technique for the treatment of hemorrhoidal disease. It alleviates symptoms by interrupting the arterial blood flow to the hemorrhoidal plexus while preserving the anatomic integrity of the anal canal. Owing to its minimally invasive nature, HAL is associated with reduced tissue trauma and improved postoperative patient satisfaction.[16] In the present study, recurrence was observed in only 9 patients (9.6%). Symptom improvement or complete resolution was achieved in 87 patients (92.6%), while 85 patients (90.4%) reported being either satisfied or partially satisfied with the treatment

TABLE 1. Descriptive Statistics on Patient Characteristics (n = 94)

	Mean±SD	Medyan (Min-Max)
Age	47.8±12.4	45.5 (24-84)
BMI	27.1±3.5	26 (22-38)
No. ligations	6.1±0.4	6 (5-7)
No. mucopecies	2.3±1	3 (0-4)
Recurrence time (mo)	3.8±2.7	3 (1-12)
Operation time (min)	25.9±5.8	26 (14-44)
		n (%)
Sex		
Male	59	62.8

TABLE 3. Evaluation of Differences in VAS Measurement Values According to Time (n = 94)

	Mean ± SD				
	First Day	First Week	First Month	*	† IIvsIII, IIvsIV, IIIvsIV
VAS	7.43±1.46	1.72±1.51	0.37±0.19	<0.001	<0.001, <0.001, <0.001

*Repeated ANOVA.

†Post hoc test, Bonferroni, P <0.05 significance.

Female	35	37.2	
ASA			
I	35	37.2	
II	53	56.4	
III	6	6.4	
Grade			
II	29	30.9	
III	49	52.1	
IV	16	17	
Prolapsus			
No	20	21.3	
Yes	74	78.7	
Bleeding			
No	31	33	
Yes	63	67	
Prolapsus and bleeding			
No	43	45.7	
Yes	51	54.3	
Analgesia type			
NSAID	43	45.7	
Tramadol	51	54.3	
Satisfaction Satisfiled			
	53	56.4	
Partially satisfied	32	34	
Dissatisfield	9	9.6	
Symptom			
Decreased	87	92.6	
Unchanged or increased	7	7.4	
Recurrence			
No	85	90.4	
Yes	9	9.6	

outcome, supporting the efficacy of the HAL procedure combined with mucopexy.

One of the primary factors influencing patient quality of life in both medical and surgical treatment of hemorrhoidal disease is recurrence following initial symptom relief. While HAL offers favorable outcomes in terms of

TABLE 2. Evaluation of the Relationship Between Bleeding and Prolapse With Dissease Grade (N = 94)

	n (%)			
Grade	II (n=29)	III (n=49)	IV (n=16)	P
Bleeding				P
No	21 (72.4)	10 (20.4)	0	<0.001
Yes	8 (27.6)	39 (79.6)	16 (100)	—
Prolapsus				
No	14 (48.3)	6 (12.2)	0	<0.001
Yes	15 (51.7)	43 (87.8)	16 (100)	—
Bleeding and prolapsus				
No	28 (96.6)	15 (30.6)	0	<0.001
Yes	1 (3.4)	34 (69.4)	16 (100)	—

χ^2 test, P <0.05 significance.

morbidity and recovery time, it may carry a slightly higher risk of recurrence compared with conventional hemorrhoidectomy.[17] A 2013 systematic review reported recurrence rates following transanal hemorrhoidal dearterialization ranging from 3% to 60%, with a pooled recurrence rate of ~17.5%.[18] This variation can be attributed to factors such as differences in surgical devices, the number of arterial ligations and mucopexies performed, and follow-up durations. In one study involving 150 patients undergoing Doppler-guided HAL with mucopexy, 36 patients (35.6%) experienced recurrence, and 20 patients (19.8%) required reoperation.[19] In contrast, the recurrence rate observed in our study (9.6%) is within the lower spectrum of the reported range, demonstrating comparable effectiveness.

Pain is a critical determinant of patient comfort and satisfaction in hemorrhoidal disease, both as a symptom and a postoperative complication. Comparative studies have shown that while long-term pain outcomes are similar, HAL offers significant advantages in terms of short-term postoperative pain when compared with conventional hemorrhoidectomy.[20] Nonetheless, early postoperative pain remains the most common complication of transanal hemorrhoidal dearterialization, with incidence rates reaching 25% in some reports,[21] while others report as low as 5%.[22] These discrepancies may be related to disease severity; patients with grade IV hemorrhoids typically report more postoperative pain than those with grade II or III disease. In our study, mean patient-reported VAS pain scores were 7.43 on postoperative day 1, 1.72 at 1 week, and 0.37 at 1 month. While initial pain scores were higher than those reported in the literature, long-term pain was significantly lower, supporting the sustained benefit of the HAL technique. For comparison, a study using the HAL-RAR method reported median VAS scores of 3 (range: 1 to 5) on day 1 and 2 (range: 1 to 3) on day 8 postoperatively.[23]

Numerous studies support the advantages of Dopplerguided HAL in terms of symptom resolution, expedited

recovery, and reduced postoperative pain relative to traditional hemorrhoidectomy.[24,25] These clinical outcomes are closely tied to patient satisfaction. In a comparative study assessing the Milligan-Morgan hemorrhoidectomy and HAL-RAR techniques, the satisfaction scores (scale 1 to 10) were significantly higher in the Milligan-Morgan group (8.11 vs 6.72, P = 0.0111).[26] In the present study, symptom resolution was noted in 92.6% of patients, and 90.4% reported being either satisfied or partially satisfied, indicating favorable outcomes for the HAL technique.

Recently, laser hemorrhoidoplasty has emerged as another minimally invasive alternative. This technique employs laser energy to reduce hemorrhoidal tissue volume and achieve hemostasis with minimal collateral tissue damage. Compared with traditional hemorrhoidectomy, laser treatment is associated with shorter operative time, less intraoperative bleeding, and quicker recovery.[27,28] Moreover, postoperative pain appears to be lower than that experienced following HAL or open procedures.[29] Despite these advantages, laser hemorrhoidoplasty is criticized for its higher cost and operator-dependent outcomes. Furthermore, while preliminary data are promising, long-term recurrence rates and comparative effectiveness remain insufficiently studied.[30] Although laser treatment was not directly compared in our study, its potential merits further investigation through prospective randomized trials evaluating outcomes such as recurrence, postoperative pain, and patient satisfaction.

This study has several limitations. First, it is a retrospective analysis, and subjective outcomes such as symptoms and satisfaction are based on patient self-reports, introducing the risk of perceptual bias. Second, the study was conducted at a single center with a limited sample size. Perhaps most significantly, we did not include a control group treated with other modalities such as MilliganMorgan, Ferguson hemorrhoidectomy, or laser therapy.

Nevertheless, despite these limitations, the current study contributes valuable data to the literature on HAL. While it is single-centered, it included an adequate number of patients and maintained a follow-up period exceeding 1 year, which is particularly important since recurrences typically occur within the first year postoperatively. These factors constitute notable strengths of our study.

CONCLUSION

The findings of the present study suggest that Dopplerguided hemorrhoidal artery ligation (HAL), with or without concomitant mucopexy, is a safe, effective, and minimally invasive surgical option for the treatment of symptomatic hemorrhoidal disease. This technique is associated with several advantages, including high therapeutic success rates, low recurrence rates, reduced operative duration, minimal postoperative complications, and high levels of patient satisfaction. These benefits make HAL ± mucopexy particularly suitable for patients with grade III hemorrhoidal disease who do not respond adequately to medical or conservative therapy. In light of the favorable short- and long-term outcomes observed in our patient cohort, this technique may be considered a first-line surgical treatment option in appropriately selected cases. Furthermore, its minimally invasive nature and favorable recovery profile support its use in enhancing overall patient quality of life and postoperative experience.

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