

Original Research Article

Transanal hemorrhoidal dearterialization for hemorrhoid treatment at International Medical Center, Jeddah: a retrospective analysis of patient outcome

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ABSTRACT

Background: The objective is to evaluate the clinical outcomes of THD with and without mucopexy in patients with symptomatic hemorrhoidal disease.

Methods: Retrospective cohort study of 105 patients who underwent THD at a tertiary care center in Jeddah between January 2020 and December 2024. Data were extracted from electronic medical records including patient demographics, operative details, and postoperative outcomes. Primary outcomes included recurrence rates, complications, pain scores, operative time, and hospital stay. Outcomes were compared between THD alone (n=28) and THD with mucopexy (n=33) using chi-square, t-test, and Mann-Whitney U tests. Statistical significance was set at $p < 0.05$.

Results: Median age was 42 years (IQR 32-52) with 58% being males. Recurrence occurred in 13% of THD alone patients versus 33% of THD with mucopexy patients ($p=0.233$). Postoperative complications were 7.4% (THD alone) versus 19% (THD with mucopexy), $p=0.3$. Median pain scores were 3/10 in both groups ($p=0.694$). Operative time was 42 minutes in both groups ($p=0.4$). Recurrence rates by grade: Grade II 17%, Grade III 43%, Grade IV 9%.

Conclusions: THD appears safe with favorable pain control and low complication rates. No significant differences were observed between THD alone and THD with mucopexy. However, short follow-up duration and substantial missing data limit definitive conclusions regarding long-term efficacy.

Keywords: Hemorrhoids, Transanal hemorrhoidal dearterialization, Mucopexy, Minimally invasive surgery, Recurrence, Postoperative complications, Doppler-guided hemorrhoidal artery ligation

INTRODUCTION

Hemorrhoidal disease represents a prevalent colorectal condition impacting populations globally. The estimated prevalence of symptomatic hemorrhoids ranges from 4% to 36% within the general population, varying with

diagnostic criteria and demographic factors, with a higher incidence observed in individuals aged 45–65 years.^{1,2}

Internal hemorrhoids originate from the prolapse of vascular tissue, lined by columnar epithelium, within the superior hemorrhoidal plexus. Conversely, external

hemorrhoids develop from the inferior hemorrhoidal plexus. The severity of vascular prolapse and associated symptoms, including bleeding, mucous discharge, pain, and prolapse, are categorized using the Goligher classification system (Grades I–IV).^{3,4} Although rarely life-threatening, symptomatic hemorrhoids significantly diminish quality of life, frequently prompting patients to seek medical intervention.

The management of hemorrhoidal disease typically follows a stepwise approach, advancing from conservative strategies to more invasive interventions. Initial management commonly involves dietary modifications, increased fluid intake, stool softeners, and topical preparations.^{5,6} For patients unresponsive to conservative therapy, various office-based and operative procedures are available, such as rubber band ligation, injection sclerotherapy, infrared coagulation, and hemorrhoidectomy.^{7,8}

Traditional hemorrhoidectomy, while effective in preventing recurrence with reported rates of 0–6%, is often associated with considerable postoperative pain, morbidity, and prolonged recovery, which limits its widespread use as a primary operative treatment.^{9,10} Complications of hemorrhoidectomy, including severe postoperative pain (frequently necessitating opioid analgesia), urinary retention, infection, and anal stenosis, have spurred the development of less invasive surgical alternatives.

Transanal hemorrhoidal dearterialization (THD), also known as Doppler-guided hemorrhoidal artery ligation (HAL), has emerged over the past two decades as a minimally invasive surgical approach with increasing acceptance. This procedure involves the identification and selective ligation of the six main hemorrhoidal arteries under Doppler ultrasound guidance, thereby reducing blood flow to the hemorrhoidal plexus and alleviating venous congestion.^{11,12}

In many instances, mucopexy is concurrently performed with dearterialization to address prolapse, particularly in advanced hemorrhoid grades.¹² THD offers several potential advantages over conventional hemorrhoidectomy, including reduced postoperative pain, shorter operative time, minimal tissue trauma, rapid recovery, and high patient acceptability.^{13,14}

Numerous prospective studies and randomized controlled trials have substantiated the efficacy and safety of THD. Recurrence rates have been reported between 2.8% and 18%, depending on follow-up duration and patient selection, with major morbidity rates ranging from 0.8% to 3%.^{13–16} Despite growing international experience with THD, data from the Middle Eastern region remain limited. The Middle East presents unique epidemiological and healthcare system characteristics that may influence both the prevalence of hemorrhoidal disease and the outcomes of surgical interventions.

Understanding THD outcomes in this specific population is crucial for clinical decision-making, quality improvement, and benchmarking against international standards. Furthermore, the comparative effectiveness of THD performed with versus without mucopexy across varying hemorrhoid grades has not been extensively investigated in real-world clinical practice, where case complexity and surgeon experience are heterogeneous factors.

The primary objective was to evaluate the clinical outcomes of transanal hemorrhoidal dearterialization with and without mucopexy in patients with symptomatic hemorrhoidal disease treated at a tertiary care center in the Middle East.

Secondary objectives included the assessment of operative characteristics, postoperative complications, pain control, hospitalization duration, and surgeon experience as factors influencing outcomes. This study aims to provide real-world clinical data on THD outcomes in a non-Western healthcare setting and address a knowledge gap regarding the role of mucopexy as an adjunctive procedure.

METHODS

Study design and setting

This was a retrospective cohort study of patients who underwent THD for symptomatic hemorrhoidal disease between January 2020 and December 2024. The study was conducted at the International Medical Center, Jeddah, a 250-bed tertiary care private hospital with a specialized colorectal surgery department staffed by 5–6 experienced colorectal surgeons.

Study population

Inclusion criteria

Patients aged ≥ 18 years with symptomatic hemorrhoidal disease (Grade I–IV); Underwent THD (with or without mucopexy) performed by staff colorectal surgeons at the International Medical Center, Jeddah; Surgery date between January 2020 and December 2024; Available medical records with documentation of operative details and hemorrhoid grade.

Exclusion criteria

Patients with incomplete operative records (e.g., no documentation of hemorrhoid grade or surgical technique); Patients with prior hemorrhoid surgery (recurrent/revision cases); Patients undergoing concurrent colorectal procedures beyond THD (e.g., fistula repair, other anorectal pathology); Patients with inflammatory bowel disease or other conditions affecting hemorrhoid management.

Sample size

The study initially aimed to enroll a minimum of 200 consecutive patients to provide adequate statistical power for subgroup comparisons. However, review of available records during the study period yielded 105 eligible patients meeting inclusion criteria.

Data collection and variables

Patient data were retrieved from the hospital's electronic medical record (EMR) system, with follow-up information obtained from outpatient clinic records and telephone contact when available. The study protocol was reviewed and approved by the Institutional Review Board at the International Medical Center, Jeddah prior to data collection.

The retrieved information included Patient demographics, clinical characteristics, operative details, and postoperative outcomes. Operative records included Surgeon notes documenting hemorrhoid grade (Goligher classification), procedure type (THD alone vs. THD + mucopexy), operative time, number of arterial ligations performed, and intraoperative findings. Anesthesia records included anesthetic technique and medications used while Nursing records included postoperative vital signs, pain assessments, and immediate postoperative complications.

Furthermore, hospital records included length of hospital stay and discharge summaries. The outpatient clinic records included Follow-up assessments such as recurrence of symptoms, postoperative complications, and clinical examination findings. The demographics characteristics were abstracted such as age, gender, body mass index (BMI). Medical history of Smoking status, anticoagulation use, relevant comorbidities were also retrieved.

Hemorrhoid characteristics such as Grade (I–IV) according to the Goligher classification, indication of surgery (bleeding, prolapse, pain, or combination). Operative variables such as performing surgeon, operative time (in minutes), number of arterial ligations performed, use of mucopexy (yes/no), anesthetic technique, type of Doppler equipment used.

The primary outcomes were recurrence of hemorrhoid symptoms during follow-up (defined as return of bleeding, prolapse, or other hemorrhoid-related symptoms after initial resolution), Postoperative complications (urinary retention, bleeding, infection, anal fissure, or other documented adverse events), postoperative pain intensity (assessed on a 0–10 numeric rating scale at discharge), Length of hospital stay (in days) and Operative time (in minutes).

The secondary outcomes included Surgeon experience, quantified as the total number of THD procedures

performed by each surgeon during the study period, Learning curve assessment, evaluated by analyzing relationships between surgeon case volume and operative time, pain scores, complications, and recurrence rates

Statistical analysis

All analyses were conducted using R version 4.3 (R Foundation for Statistical Computing, Vienna, Austria). A two-tailed p-value of <0.05 was considered statistically significant for all analyses. Demographic and clinical characteristics of the cohort were summarized using descriptive statistics. Continuous variables are presented as mean $\pm$ standard deviation or median (interquartile range [IQR]) depending on distributional characteristics. Categorical variables are presented as counts and percentages. Baseline characteristics and outcomes were compared between procedure groups (THD alone vs. THD + mucopexy) using appropriate statistical tests:

Pearson's chi-square test or Fisher's exact test for Categorical variables, while independent samples t-test or Mann-Whitney U test, depending on normality of distribution assessed by Shapiro-Wilk test, summarized continuous variables. Outcomes stratified by hemorrhoid grade (I–IV) were compared using Kruskal-Wallis test for continuous variables and Pearson's chi-square test for categorical variables. The relationship between surgeon case volume and operative outcomes was examined using Spearman's rank correlation coefficient.

Ethical considerations

This study was approved by the Institutional Review Board at the International Medical Center, Jeddah (IMC-IRB #2025-04-272; approval date: April 08, 2025). The study was conducted in accordance with the Declaration of Helsinki. As this was a retrospective study utilizing existing medical records, a waiver of informed consent was granted by the IRB, with provisions for patient notification and data protection. For follow-up contacts via telephone (where attempted), verbal consent was obtained prior to data collection. All patient data were de-identified prior to analysis. Patients were assigned unique study identification numbers, and all identifiable information was removed from the analysis dataset. All electronic data were encrypted and stored on password-protected computers within the hospital network.

RESULTS

Overall included 105 patients who underwent THD. The cohort was predominantly male (58%, $n=61$), with a median age of 42 years (interquartile range [IQR] 32–52). The majority of patients were overweight, with a median body mass index (BMI) of 27.4 kg/m² (IQR 24.1–31.0), and most were non-smokers (81%, $n=39$). The distribution of hemorrhoid grades was as follow: Grade III hemorrhoids predominated (56%, $n=40$), followed by

Grade IV (27%, n=19), with very few patients presenting with mild disease (Grade I-II, 17%, n=12) (Table 1).

Among 61 patients with documented procedure type" before stating 28 (46%) and 33 (54%). These percentages have denominator 61. The two groups were well-matched at baseline across all measured characteristics including gender (p=0.7), age (p=0.8), BMI (p=0.8), smoking status

(p>0.9), and hemorrhoid grade distribution (p=0.9) (Table 2).

The recurrence rate differed by procedure type, THD alone demonstrated a lower recurrence rate of 13% (2 of 16 patients), while THD with mucopexy showed a higher rate of 33% (6 of 18 patients) (Figure 1).

Table 1: Demographics characteristics of study participants.

Characteristics	n=105 ¹
Gender	
Female	44 (42%)
Male	61 (58%)
Age	42 (32, 52)
Unknown	2
BMI	27.4 (24.1, 31.0)
Smoking	
No	39 (81%)
Yes	9 (19%)
Unknown	57
Grade of hemorrhoids	
I	2 (2.8%)
II	10 (14%)
III	40 (56%)
IV	19 (27%)
Unknown	34
Type of procedure	
THD only	28 (46%)
THD with mucopexy	33 (54%)
Unknown	44
¹ N (%); Median (Q1, Q3)	

Table 2: Baseline demographic and clinical characteristics stratified by procedure type.

Characteristics	Overall n=61 ¹	THD only n=28 ¹	THD with mucopexy n=33 ¹	P value ²
Gender				0.7
Female	28 (46%)	12 (43%)	16 (48%)	
Male	33 (54%)	16 (57%)	17 (52%)	
Age (years)	42 (32, 49)	42 (31, 51)	40 (35, 49)	0.8
Unknown	1	1	0	
BMI	27.4 (23.5, 30.8)	27.1 (24.1, 30.5)	27.4 (23.2, 31.2)	0.8
Smoking				>0.9
No	11 (69%)	6 (75%)	5 (63%)	
Yes	5 (31%)	2 (25%)	3 (38%)	
Unknown	45	20	25	
Grade of hemorrhoids				0.9
I	0 (0%)	0 (0%)	0 (0%)	
II	10 (18%)	5 (21%)	5 (16%)	
III	30 (55%)	13 (54%)	17 (55%)	
IV	15 (27%)	6 (25%)	9 (29%)	
Unknown	6	4	2	
¹ N (%); Median (Q1, Q3)				

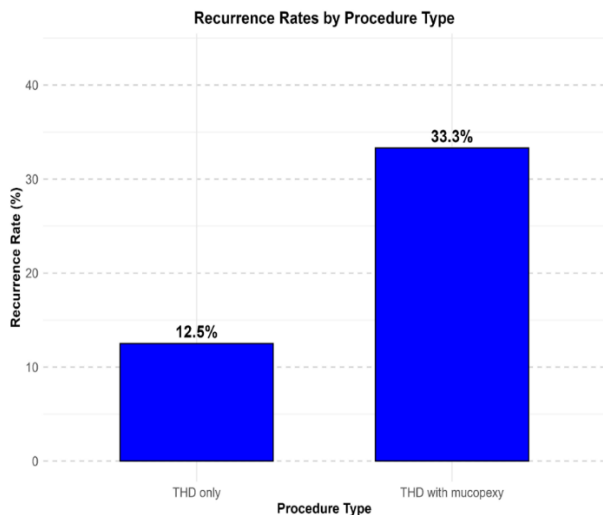


Figure 1: Recurrence rates by procedure type.

Operative characteristics were similar between procedure groups. The median operative time was 42 minutes for both THD alone and THD with mucopexy ($p=0.4$). The number of arterial ligations performed showed a trend toward more numerous ligations in the mucopexy group (median 3 ligations in both groups, but 42% requiring 4-6 ligations in THD+mucopexy vs. 22% in THD alone), though this difference did not reach statistical significance ($p=0.2$).

Postoperative pain management was generally successful in both groups. Among the 47 patients with documented pain assessment, the majority reported minimal to moderate pain (92%), with only 4 patients (8.5%)

experiencing severe postoperative pain. Pain severity did not differ significantly between procedure types ($p=0.8$). Postoperative complications occurred in 8 of 58 patients (14%) with available data, including urinary retention, minimal bleeding, difficulty with bowel function, and perineal discomfort. While the THD+mucopexy group showed a numerically higher complication rate (19% vs 7.4%), this difference was not statistically significant ($p=0.3$).

Hospital length of stay was minimal. The majority of patients (47%) were discharged on the day of surgery, with 52% admitted for 1-3 days postoperatively. There was no significant difference in hospitalization patterns between procedure groups ($p=0.7$). A notable difference emerged in the baseline prevalence of anal fissure or fistula: these comorbidities were significantly more common in the THD alone group (32% vs 9.4%, $p=0.028$). This unexpected finding suggests either differential patient selection or that more complex anatomy prompted the additional mucopexy procedure in some cases. Previous hemorrhoidal treatments did not differ between groups (22% THD alone vs 11% THD+mucopexy, $p=0.3$).

Among 34 patients with documented follow-up data on recurrence (median follow-up duration 1.2 months), 8 patients (24%) experienced symptomatic recurrence of hemorrhoidal symptoms. The recurrence rate differed by procedure type, though not reaching statistical significance: THD alone demonstrated a lower recurrence rate of 13% (2 of 16 patients), while THD with mucopexy showed a higher rate of 33% (6 of 18 patients) ($p=0.2$) (Table 3).

Table 3: Operative outcomes stratified by procedure type.

Characteristics	Overall n=61 ¹	THD only n=28 ¹	THD with mucopexy n=33 ¹	P value ²
History of previous hemorrhoidal treatments				0.3
No	46 (84%)	21 (78%)	25 (89%)	
Yes	9 (16%)	6 (22%)	3 (11%)	
Unknown	6	1	5	
Presence of anal fissure or fistula				0.028
No	48 (80%)	19 (68%)	29 (91%)	
Yes	12 (20%)	9 (32%)	3 (9.4%)	
Unknown	1	0	1	
Length of operation in minutes	42 (37, 59)	42 (36, 53)	42 (37, 65)	0.4
Number of arterial ligations performed				0.2
0	0 (0%)	0 (0%)	0 (0%)	
1 to 3	39 (67%)	21 (78%)	18 (58%)	
4 to 6	19 (33%)	6 (22%)	13 (42%)	
Unknown	3	1	2	
Postoperative pain score				0.8
Mild	0 (0%)	0 (0%)	0 (0%)	
Minimal	20 (43%)	10 (48%)	10 (38%)	
Moderate	23 (49%)	9 (43%)	14 (54%)	

Continued.

Characteristics	Overall n=61 ¹	THD only n=28 ¹	THD with mucopexy n=33 ¹	P value ²
Severe	4 (8.5%)	2 (9.5%)	2 (7.7%)	
Unknown	14	7	7	
Postoperative complications				0.3
No	50 (86%)	25 (93%)	25 (81%)	
Yes	8 (14%)	2 (7.4%)	6 (19%)	
Unknown	3	1	2	
Length of hospital stay				0.7
0	28 (47%)	12 (44%)	16 (48%)	
1 to 3	31 (52%)	14 (52%)	17 (52%)	
5	1 (1.7%)	1 (3.7%)	0 (0%)	
7	0 (0%)	0 (0%)	0 (0%)	
Unknown	1	1	0	
Recurrence of symptoms				0.2
No	26 (76%)	14 (88%)	12 (67%)	
Yes	8 (24%)	2 (13%)	6 (33%)	
Unknown	27	12	15	
¹ N (%); Median (Q1, Q3)				
² Fisher's exact test; Pearson's Chi-squared test; Wilcoxon rank sum test				
Bold represents statistically significant (p<0.05)				

Analysis stratified by hemorrhoid grade revealed important patterns. Postoperative complications occurred in 24% of Grade III patients but in 0% of both Grade II and

Grade IV patients (p=0.052). Operative characteristics did not significantly vary by grade. Operative time remained consistent across grades (p>0.9). The number of arterial ligations increased with grade severity from 40% requiring 4-6 ligations in Grade II to 60% in Grade IV, although this was not statistically significant

(p=0.12). Regarding the association between recurrence and hemorrhoid grade, among 40 patients with complete data on both grade and recurrence status, Grade III hemorrhoids showed the highest recurrence rate at 43% (9 of 21 patients). In contrast, Grade IV disease demonstrated the lowest recurrence at 9% (1 of 11 patients), while Grade II disease showed an intermediate rate of 17% (1 of 6 patients with complete data). The relationship between disease severity and recurrence outcome did not achieve statistical significance across grades (p=0.2) (Table 4).

Table 4: Stratified analysis of the primary outcomes of recurrence and postoperative complications

Characteristic	I n=2 ¹	II n=10 ¹	III n=40 ¹	IV n=19 ¹	P value ²
History of previous hemorrhoidal treatments					0.3
No	2 (100%)	6 (67%)	30 (79%)	15 (94%)	
Yes	0 (0%)	3 (33%)	8 (21%)	1 (6.3%)	
Unknown	0	1	2	3	
Presence of anal fissure or fistula					0.4
No	1 (50%)	7 (78%)	31 (79%)	17 (89%)	
Yes	1 (50%)	2 (22%)	8 (21%)	2 (11%)	
Unknown	0	1	1	0	
Length of operation in minutes	42 (42, 42)	47 (24, 72)	42 (37, 52)	42 (29, 56)	>0.9
Number of arterial ligations performed					0.12
0	0 (NA%)	0 (0%)	1 (3.2%)	0 (0%)	
1 to 3	0 (NA%)	4 (40%)	24 (77%)	10 (71%)	
4 to 6	0 (NA%)	6 (60%)	6 (19%)	4 (29%)	
Unknown	2	0	9	5	
Postoperative pain score					0.8
Mild	0 (NA%)	0 (0%)	0 (0%)	1 (6.3%)	
Minimal	0 (NA%)	3 (38%)	12 (44%)	7 (44%)	
Moderate	0 (NA%)	4 (50%)	13 (48%)	6 (38%)	

Continued.

Characteristic	I n=2 ¹	II n=10 ¹	III n=40 ¹	IV n=19 ¹	P value ²
Severe	0 (NA%)	1 (13%)	2 (7.4%)	2 (13%)	
Unknown	2	2	13	3	
Postoperative complications					0.052
No	2 (100%)	10 (100%)	29 (76%)	18 (100%)	
Yes	0 (0%)	0 (0%)	9 (24%)	0 (0%)	
Unknown	0	0	2	1	
Length of hospital stay					0.3
0	1 (100%)	5 (56%)	12 (30%)	8 (42%)	
1 to 3	0 (0%)	4 (44%)	27 (68%)	10 (53%)	
5	0 (0%)	0 (0%)	0 (0%)	1 (5.3%)	
7	0 (0%)	0 (0%)	1 (2.5%)	0 (0%)	
Unknown	1	1	0	0	
Recurrence of symptoms					0.2
No	2 (100%)	5 (83%)	12 (57%)	10 (91%)	
Yes	0 (0%)	1 (17%)	9 (43%)	1 (9.1%)	
Unknown	0	4	19	8	
¹ N (%); Median (Q1, Q3)					
² Fisher's exact test; Kruskal-Wallis rank sum test					

DISCUSSION

As a minimally invasive intervention, THD gained increasing acceptance in the management of symptomatic hemorrhoidal disease. The procedure has been proposed as an alternative to conventional hemorrhoidectomy because of its potential to reduce postoperative discomfort while maintaining satisfactory clinical outcomes.^{13,14,17} Furthermore, THD has been shown to be effective in the treatment of rectal outlet bleeding.¹⁸

The recurrence rates observed in our study appear higher than those reported in the literature. In a large multicenter study of 1,000 patients, Ratto et al. reported an overall recurrence rate of 9.5%, with recurrence rates of 8.5%, 8.7%, and 18.1% among patients with grade II, III, and IV hemorrhoids, respectively.¹² Similarly, Ratto et al reported a reoperation rate of 4.1% after a median follow-up of 11.5 months, while Atallah et al reported recurrence rates ranging from 2.8% to 7.1% during a median follow-up of 6 months.^{19,16} LaBella et al observed recurrent prolapse in 10.3% of patients at one year.²⁰ However, direct comparison with these studies should be undertaken with caution because follow-up duration in our study was considerably shorter and recurrence data were unavailable for a substantial proportion of patients. The relatively high recurrence rates observed may also reflect differences in patient selection, case complexity, surgeon technique, or incomplete follow-up capture. An unexpected finding was the higher recurrence rate observed among patients with Grade III hemorrhoids compared with those with Grade IV disease. This pattern contrasts with previous studies, which generally reported increasing recurrence with greater disease severity.^{12,20} However, the number of patients with complete recurrence data was limited, particularly within

individual grade categories, and therefore this finding should be interpreted with caution.

Postoperative complications occurred in 14% of patients overall and did not differ substantially between treatment groups. These findings are broadly consistent with previous reports demonstrating the safety profile of THD. Ratto et al. reported low rates of postoperative morbidity, including pain or tenesmus in 3.1%, urinary retention in 2.3%, thrombosed external hemorrhoids in 0.8%, and postoperative bleeding in 1.4% of patients.¹² Similarly, Atallah et al found no significant increase in postoperative morbidity among anticoagulated patients and reported no requirement for reintervention.¹⁶ In our cohort, most complications were minor and managed conservatively.

Operative times in the current study were longer than those reported in previous series. Median operative time was 42 minutes in both groups, compared with approximately 20 minutes for dearterialization alone and 30 minutes for THD with mucopexy in previous reports.^{12,19} These differences may reflect variation in operative technique, case complexity, institutional practice patterns, or surgeon experience. Nevertheless, postoperative pain remained low in our cohort, with a median pain score of 3/10, supporting the minimally invasive nature of the procedure.

Hospital stay was brief in both treatment groups, with most patients discharged within one day of surgery. This finding is consistent with previous studies demonstrating that THD is commonly performed as a day-case or short-stay procedure.^{12,19} Together with the low postoperative pain scores observed, these findings support the role of

THD as a minimally invasive treatment associated with rapid postoperative recovery.

The strengths of this study include the evaluation of THD outcomes in a real-world tertiary care setting and the inclusion of patients with predominantly advanced hemorrhoidal disease. In addition, several clinically relevant outcomes were assessed, including recurrence, postoperative complications, operative characteristics, and perioperative recovery measures. Several limitations should be acknowledged. First, the retrospective design is inherently susceptible to selection bias, information bias, and incomplete documentation. Second, a substantial proportion of data were missing for several variables, particularly recurrence outcomes, smoking status, hemorrhoid grade classification, and operative details. To address this issue, analyses were performed using complete-case methodology; however, this approach may introduce bias if missingness was not random. Third, the relatively small number of patients with complete follow-up data limited statistical power and reduced the precision of effect estimates.

This limitation reduced the precision of the effect estimates and may have limited the ability to detect meaningful differences between treatment groups. Fourth, the median follow-up duration was short, limiting the ability to assess long-term recurrence and durability of treatment. Finally, the single-center design may limit the generalizability of the findings.

CONCLUSION

THD appears to be a safe and minimally invasive treatment option for symptomatic hemorrhoidal disease, with low postoperative pain scores, short hospital stays, and acceptable short-term postoperative outcomes. Although recurrence was numerically more frequent among patients undergoing THD with mucopexy, the study was underpowered to detect statistically significant differences between treatment groups. Larger prospective studies with standardized long-term follow-up are needed to better define recurrence patterns and evaluate factors associated with treatment outcomes following THD.

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Ethical approval: The study was approved by the Institutional Ethics Committee

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