

## **A NEW SURGICAL APPROACH TO HEMORRHOIDECTOMY: LATERAL ULTRASONIC DISSECTION WITH MINIMAL THERMAL INJURY**

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**Abstract.** Hemorrhoidectomy remains the standard surgical treatment for advanced hemorrhoidal disease, but it is associated with considerable tissue trauma and postoperative pain. A novel technique of hemorrhoidectomy using lateral ultrasonic dissection in the “cutting” mode has been developed to reduce tissue injury while ensuring effective hemorrhoid removal and hemostasis.

The lateral ultrasonic dissection hemorrhoidectomy in cutting mode demonstrated superior outcomes to conventional surgery, with reduced tissue trauma, lower complication rates, less postoperative pain, and faster functional recovery. This technique provides a safe and effective alternative for advanced hemorrhoid disease, combining reliable hemostasis with a more physiologic healing process.

**Keywords.** Hemorrhoids; lateral ultrasound dissection (cutting mode); ultrasonic scalpel; Milligan–Morgan hemorrhoidectomy; electrocautery; transanal manometry; histopathology; coagulation necrosis.

**Introduction.** Hemorrhoidal disease is one of the most common anorectal pathologies worldwide. Epidemiological studies indicate a prevalence of symptomatic hemorrhoids in approximately 10–20% of the adult population in developed countries[14]. Sedentary lifestyle factors, including physical inactivity and prolonged sitting, as well as low-fiber diets leading to chronic constipation, are significant contributors to hemorrhoid development. As a result, hemorrhoids are frequently encountered in middle-aged individuals, often causing substantial discomfort and reduction in quality of life. However, due to the sensitive nature of this condition, many patients delay seeking medical care, with initial specialist examination commonly occurring 5–15 years after symptom onset. This delay in presentation contributes to a high proportion of patients (often >60%) presenting with advanced stage (III–IV) hemorrhoids that require surgical intervention.

Surgical hemorrhoidectomy (particularly the Milligan–Morgan open technique) has long been the gold standard for stage III–IV hemorrhoids. It

provides definitive removal of pathological hemorrhoidal tissue (ensuring “radical” treatment) but is associated with extensive tissue excision and an inevitably large wound in the anal region. Consequently, the traditional procedure carries a postoperative complication rate of about 15–20%, including pain, bleeding, urinary retention, anal stenosis, and, rarely, sphincter injury leading to incontinence. Some complications can be severe or debilitating, and hemorrhoid recurrence rates of 10–15% have been reported even after seemingly adequate surgery. Moreover, intense postoperative pain is nearly universal after conventional hemorrhoidectomy due to the richly innervated anoderm, often significantly delaying patient recovery and return to normal activities. Postoperative pain not only prolongs rehabilitation but may itself precipitate complications (for example, pain-related urinary retention or progression to chronic pain syndrome). Therefore, improving postoperative comfort and reducing pain has become a major focus in optimizing hemorrhoid treatment outcomes.

In recent decades, there has been growing interest in minimally invasive treatments for hemorrhoids (such as rubber band ligation, Doppler-guided hemorrhoidal artery ligation, and stapled hemorrhoidopexy), which aim to reduce perioperative pain and hasten recovery. While these techniques can be effective for early-stage hemorrhoids, their role in advanced grade hemorrhoids is limited; stages III–IV often still require excisional hemorrhoidectomy for definitive resolution. Thus, Milligan–Morgan hemorrhoidectomy remains indispensable for advanced cases. To mitigate the drawbacks of conventional surgery, numerous modifications have been proposed, particularly utilizing modern energy devices to achieve tissue dissection and hemostasis with less trauma. Vessel-sealing devices, bipolar diathermy, laser, and ultrasonic scalpels have all been applied to hemorrhoidectomy with the goal of reducing operative time, blood loss, and thermal injury to tissues. Among these, the harmonic scalpel (ultrasonic scalpel) has gained popularity since the early 21st century as a promising tool for hemorrhoidectomy. Ultrasonic energy allows simultaneous cutting and coagulation by vibrating at high frequency, potentially resulting in a more precise dissection with limited depth of thermal spread compared to monopolar cautery.

Despite encouraging reports of ultrasonic hemorrhoidectomy achieving reduced blood loss and postoperative pain, many questions remain open. Prior studies have often utilized the ultrasonic device primarily in coagulation mode (lower power) for hemorrhoid excision. This approach prioritizes hemostasis but can produce a relatively deeper zone of tissue coagulation (approximately 0.3–0.4 mm) and carries a risk of delayed hemorrhage when the coagulum sloughs from the pedicle stump. It has been hypothesized that the full potential of ultrasonic technology in hemorrhoid surgery has not yet been realized. In particular, using the ultrasonic scalpel in the “cutting” mode (high-power) could

minimize thermal injury if combined with adequate vessel ligation for hemostasis. Therefore, further refinement of the ultrasonic technique – specifically employing lateral tissue dissection in cutting mode – may yield improved patient outcomes. The relevance of investigating this new modification lies in its promise to reduce surgical trauma without compromising the radical nature of the hemorrhoidectomy or its safety.

In summary, the high prevalence of hemorrhoidal disease and the significant morbidity associated with its surgical treatment make it imperative to seek improved techniques. The present study addresses this need by evaluating an innovative hemorrhoidectomy method using lateral ultrasonic dissection in cutting mode, aimed at enhancing patient recovery and reducing complications. We hypothesize that this technique will be more “physiological,” causing less collateral damage to tissues (and thus less pain and faster healing) while maintaining effective removal of hemorrhoidal tissue and secure hemostasis.

### **Aim of the Study**

To substantiate the effectiveness and safety of hemorrhoidectomy with lateral ultrasonic dissection in the “cutting” mode.

**Materials and Methods.** Study Design and Patients: A comprehensive comparative study was conducted, involving 120 patients with chronic stage III–IV hemorrhoidal disease who underwent surgical treatment at our institution. The patients were divided into two groups: a main group of 70 patients who underwent hemorrhoidectomy using the original lateral ultrasound dissection technique in cutting mode, and a control group of 50 patients who underwent conventional open hemorrhoidectomy by the Milligan–Morgan technique with monopolar electrocautery[3][4]. Inclusion criteria comprised adults with grade III or IV combined internal/external hemorrhoids requiring surgery; patients with acute thrombosis, inflammatory anorectal conditions, or prior anal surgery were excluded. The groups were well matched in baseline characteristics. As summarized in Table 1, there were no significant differences between the main and control groups in terms of sex distribution, mean age, hemorrhoid stage breakdown, or comorbid conditions. Notably, about two-thirds of patients in each group had grade IV hemorrhoids, and roughly 15–17% had coexisting chronic anal fissures. The Charlson comorbidity index averaged ~4.7 in both groups, reflecting a similar burden of systemic comorbidities (common in this older patient population).

To ensure an objective comparison of pain levels, patients in both groups were surveyed each day with the same questionnaire at roughly the same times. Analgesic requirements were recorded (NSAIDs vs need for opioid use) as an indirect indicator of pain severity.

Additionally, a histopathological examination was performed on the hemorrhoid specimens from each patient. Resected hemorrhoidal tissue was fixed in formalin and examined microscopically after H&E staining. We specifically measured the depth of coagulation necrosis in the tissues (the thickness of the zone of thermal injury at the resection surface) using an ocular micrometer. We also qualitatively assessed morphological changes in the adjacent tissues, noting the presence of any carbonization, necrobiotic changes, inflammatory response, and vascular changes in small vessels (e.g. fibrinoid necrosis or spasm).

Anal sphincter function was evaluated via balloonographic anorectal manometry in a subset of patients. In both groups, anorectal manometry was performed preoperatively and again on the 3rd postoperative day to assess early functional impact. We measured the resting anal pressure and the maximal squeeze pressure using a rectal balloon catheter and pressure transducer system. The relative change in these pressures from pre- to post-surgery was calculated for each patient. We paid particular attention to any development of sphincter insufficiency (defined as a significant drop in resting tone with incontinence symptoms) or other functional impairment.

For long-term outcomes, patients were followed at outpatient visits or contacted via telephone. The median follow-up period was about 2 years, with a range from 6 months up to 5 years post-surgery. At last follow-up, we evaluated: - Recurrence of hemorrhoids: defined as return of symptomatic hemorrhoids (persistent bleeding or prolapse) requiring any further intervention. - Late complications: such as anal stricture (and need for dilation), chronic anal fissure, or fecal incontinence. - Patient-reported outcomes: including general satisfaction and, where possible, quality of life measures. (A formal quality-of-life questionnaire specific to anorectal surgery, as used by some authors[34], was not uniformly applied, but patients were asked about their continence, pain, and overall comfort in daily life.)

All data were collected and analyzed using standard statistical methods. Continuous variables (e.g. age, operative time, pain scores) are presented as mean  $\pm$  standard deviation and were compared between groups using the Student's t-test. Categorical variables (e.g. complication rates, percentage of patients with severe pain) were compared using chi-square or Fisher's exact test as appropriate. A p-value  $< 0.05$  was considered statistically significant. Statistical analysis was performed with SPSS 20.0 software. Given the sample size, the study had adequate power to detect large differences in primary outcomes (pain and complications); however, some subgroup analyses (e.g. rare complications) were descriptive due to low incidence.

Ethical approval was obtained from the Institutional Review Board, and all patients provided informed consent for the treatment and use of their de-identified data.

**Results and Discussion.** Operative and Immediate Postoperative Results: Both the new ultrasonic dissection technique and the conventional surgery were completed safely in all patients without major intraoperative complications. The mean operative time in the main group was  $29 \pm 6$  minutes, slightly shorter than  $35 \pm 7$  minutes in the control group (Table 2), although this difference did not reach statistical significance ( $p = 0.11$ ). The trend toward reduced operating time with the ultrasonic technique may be attributed to the efficient cutting and coagulating action of the harmonic scalpel, which can simplify bleeding control. However, due to the additional step of suturing the pedicles, the time savings were not pronounced. No intraoperative bleeding requiring additional intervention occurred in either group; both methods provided adequate hemostasis, with the ultrasonic scalpel's coagulative effect and suture ligations in the main group effectively preventing hemorrhage.

Postoperative complications within the initial recovery period were notably different between the two groups. In the main (ultrasonic) group, only 4 out of 70 patients (5.7%) experienced any postoperative complication, whereas in the control group 10 out of 50 patients (20%) had complications[37][38]. This represents a significant reduction in overall complication rate with the ultrasonic dissection ( $p = 0.02$ ). The specific types of complications observed are detailed in Table 2. In the control group, eight patients (16%) had acute urinary retention, a well-known issue after anorectal surgery often related to pain and pelvic floor spasm; by contrast, urinary retention occurred in four patients (6%) in the main group. Usually, these were managed with temporary catheterization. Transient anal incontinence (grade I), manifesting as minor soiling, was noted in 2 patients (4%) in the control group in the immediate postoperative days; none of the ultrasonic group patients had this issue. This minor incontinence was transient and resolved spontaneously by 1–2 weeks, likely due to stretching or edema of the anal sphincter; however, its absence in the main group suggests less trauma to the sphincter mechanism with the new technique. Anal stricture (narrowing due to scar) was observed in one control patient (2%) at 2 months post-op, who required anal dilations, whereas no strictures developed in the main group. There were no cases of significant secondary hemorrhage in either group. Importantly, no patient in the ultrasonic group required reoperation or readmission for any complication, while in the control group one patient (2%) was brought back for day-surgery dilation of the stricture. The shorter wound healing time in the main group likely contributed to the lower complication profile; on average the duration of postoperative wound healing (time to complete epithelialization) was about one week shorter in the main



group than in controls, as evidenced by follow-up examination (complete healing in ~4 weeks vs ~5 weeks, respectively).

**Table 2**

**Surgical outcomes in the immediate postoperative period for both groups (absolute numbers with percentage in parentheses). Note: one control group patient experienced two complications (urinary retention and stricture)**

| Outcome                            | Main group<br>(n=70) | Control group<br>(n=50) | p-value |
|------------------------------------|----------------------|-------------------------|---------|
| Operative time, min                | 29 ± 6               | 35 ± 7                  | 0.11    |
| Overall complications, n (%)       | 4 (6%)               | 10 (20%)*               | 0.02    |
| – Urinary retention                | 4 (6%)               | 8 (16%)                 | 0.11    |
| – Transient incontinence (Grade I) | 0 (0%)               | 2 (4%)                  | 0.17    |
| – Anal stricture                   | 0 (0%)               | 1 (2%)                  | 0.40    |
| Postoperative hospital stay, days  | 3.5 ± 0.5            | 4.5 ± 0.5               | 0.09    |

As seen above, urinary retention was the most common complication in both groups. Its incidence was lower in the main group (6% vs 16%), reflecting the impact of reduced pain and irritation (since severe pain can inhibit normal voiding reflex). Although this difference did not reach statistical significance with our sample size, the trend is clinically favorable. The absence of any incontinence or stricture in the ultrasonic group is notable; these issues in the control group, while infrequent, underscore the consequences of greater tissue injury and scarring from the traditional technique. In fact, our observed overall complication rate of 6% with the new method falls at the low end of the range reported in the literature (which varies widely from about 4% up to 30% depending on patient mix and definitions)[40][41]. This suggests that the lateral ultrasonic dissection approach yields a very favorable immediate postoperative course.

Perhaps one of the most striking early benefits of the ultrasonic technique was the reduction in postoperative pain. Pain intensity in the first days after surgery was systematically lower in the main group than in controls. We measured pain on a daily basis using the VAS and our composite questionnaire. Figure 2 illustrates the comparative pain score dynamics over the first 5 postoperative days. On postoperative day 1, patients in the control group reported high pain levels (often VAS 7–8 out of 10) despite analgesics, whereas the main group's pain scores were more moderate (around VAS 4–5). The pain remained consistently lower in the ultrasonic group on each subsequent day. By day 5, pain had decreased substantially in both groups, but the main group's average pain was nearly minimal (mild discomfort only) while the control group still reported moderate pain.

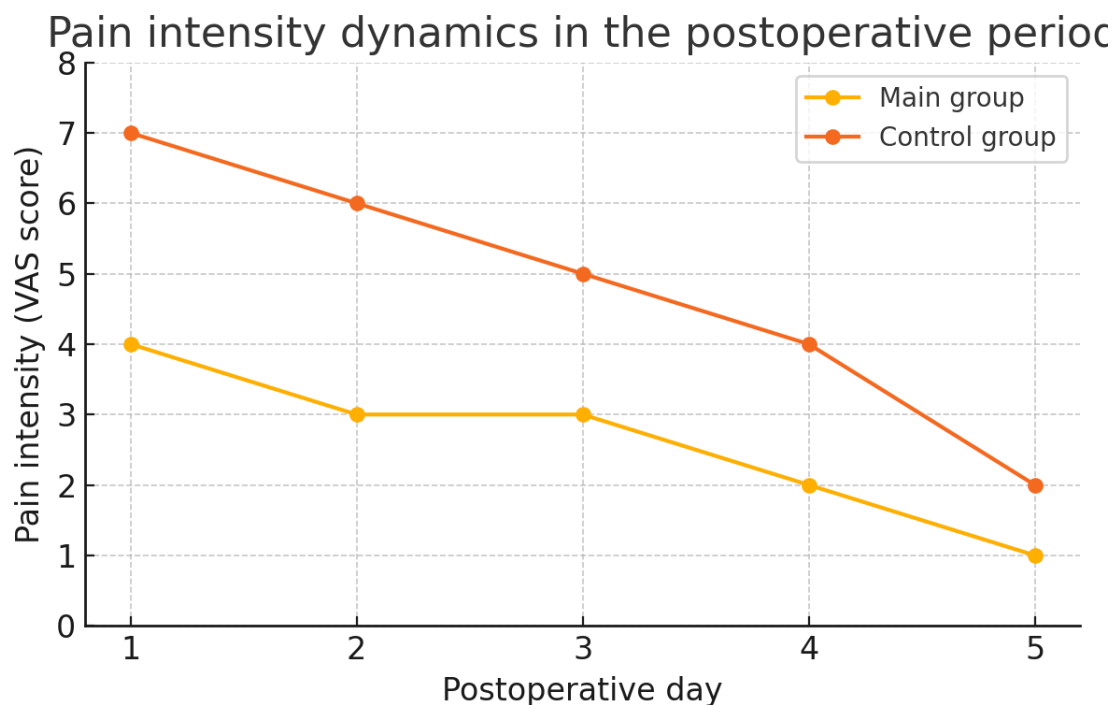


Figure 2. Comparative dynamics of postoperative pain intensity (VAS score) over 5 days in the two groups. Patients who underwent hemorrhoidectomy with lateral ultrasonic dissection experienced significantly less pain at all time points. By the end of day 5, pain scores in the ultrasonic group approached zero (minimal pain), whereas the control group still had notable pain. This reduction in pain is attributed to the less traumatic nature of the ultrasonic dissection technique, resulting in smaller wounds and less nerve irritation. All patients in the main group achieved satisfactory pain control with NSAIDs alone; in contrast, 4 patients (8%) in the control group required opioid analgesics for adequate pain relief during the first 2 days[5]. The ability to avoid narcotics in the majority of ultrasonic group patients not only indicates milder pain but also helped accelerate their recovery (by avoiding opioid-related side effects such as constipation). Early mobilization was easier for patients with less pain, and this likely contributed to the faster functional recovery observed.

Our findings reinforce the concept that postoperative pain is directly related to the extent of tissue damage during surgery[22]. By minimizing collateral thermal injury, the ultrasonic dissection technique reduces nociceptive input. This has a cascading beneficial effect: less pain → less reflex spasm of pelvic muscles → fewer secondary issues like urinary retention → improved patient mobility and confidence. Pain control is crucial not only for patient comfort but also because uncontrolled pain can lead to a cycle of delayed wound healing and even chronic pain development in some cases[42]. The significantly lower pain scores in the

main group are therefore a key indicator of the enhanced tolerability of the new technique.

Corresponding to lower pain and fewer complications, the postoperative hospital stay tended to be shorter for the main group. On average, main group patients were discharged about 1 day earlier than control group patients (mean 3.5 vs 4.5 days,  $p = 0.09$ , Table 2). While this difference was just outside statistical significance, it is clinically meaningful. Many ultrasonic group patients, with their milder pain and uncomplicated recovery, were able to be discharged after 3 days (once comfortable with bowel movements), whereas several control patients required an extra day of inpatient care for pain management or complication observation. Early discharge is beneficial in terms of healthcare resource utilization and patient convenience, and none of the early-discharged ultrasonic patients needed readmission.

Anal continence and sphincter integrity are paramount concerns in hemorrhoid surgery. Even temporary impairment of sphincter function can greatly affect quality of life. In our study, we quantitatively assessed sphincter function changes using transanal manometry before and after surgery. The main finding was that the lateral ultrasonic dissection caused minimal disturbance to sphincter pressures, whereas conventional surgery led to a more marked reduction. Prior to surgery, mean resting and squeeze pressures were comparable in the two groups (indicative of normal function in all patients). By the third day after surgery, manometry in the control group often showed a substantial drop in maximal voluntary squeeze pressure and some decrease in resting tone, consistent with pain-related guarding and perhaps minor nerve or muscle injury from the extensive excision. In contrast, the ultrasonic group's manometry curves remained much closer to baseline. Quantitatively, the difference between pre- and postoperative pressure metrics averaged  $<10\%$  in the main group vs. about  $30\%$  in the control group. For example, if a patient's maximal squeeze pressure was 120 mmHg preoperatively, it might remain  $\sim 110$  mmHg after ultrasonic hemorrhoidectomy, but drop to  $\sim 80$  mmHg after electrocautery hemorrhoidectomy. Figure 3 and Figure 4 present illustrative manometry tracings for each group.



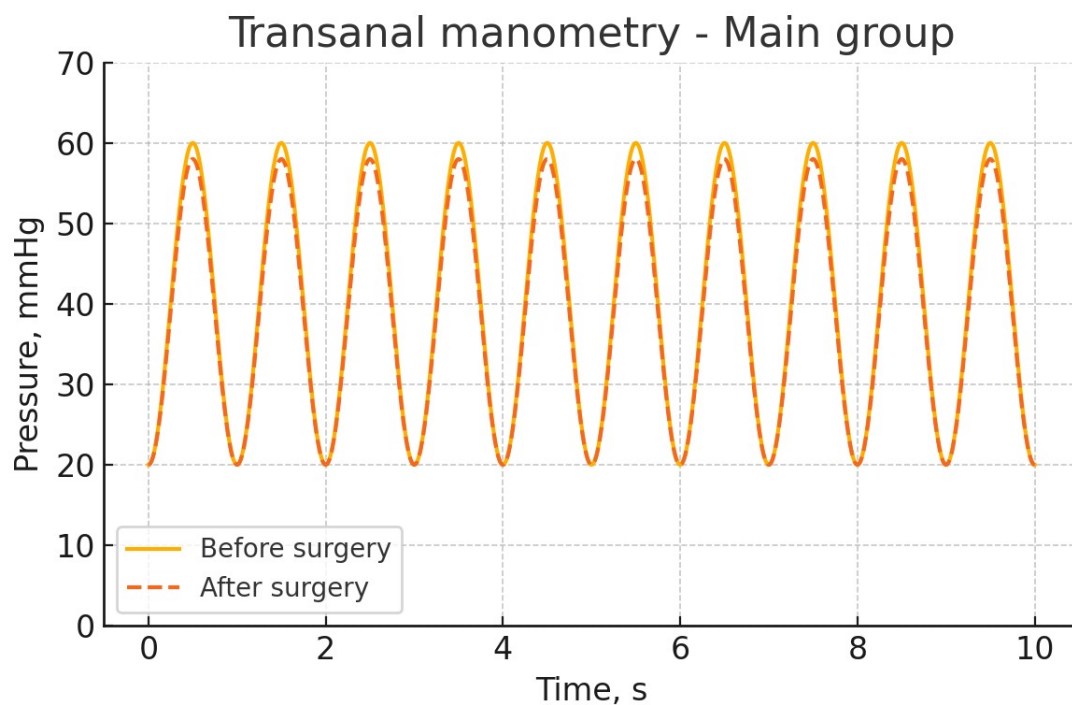


Figure 3. Transanal manometry tracings for a representative patient in the main group before and after hemorrhoidectomy with lateral ultrasonic dissection. The solid line indicates the anal pressure wave (rectal resting tone with periodic contractions) before surgery, and the dashed line shows the tracing on postoperative day 3. In the main group, only a minimal change is observed – the amplitude and duration of contractions are almost superimposable pre- vs post-op, with <10% difference. This indicates that the ultrasonic technique preserved the neuromuscular function of the anal sphincter complex. Such preservation is likely due to the reduced trauma and precise nature of the dissection, which spares the sphincter muscles and the innervated anoderm to a greater extent.

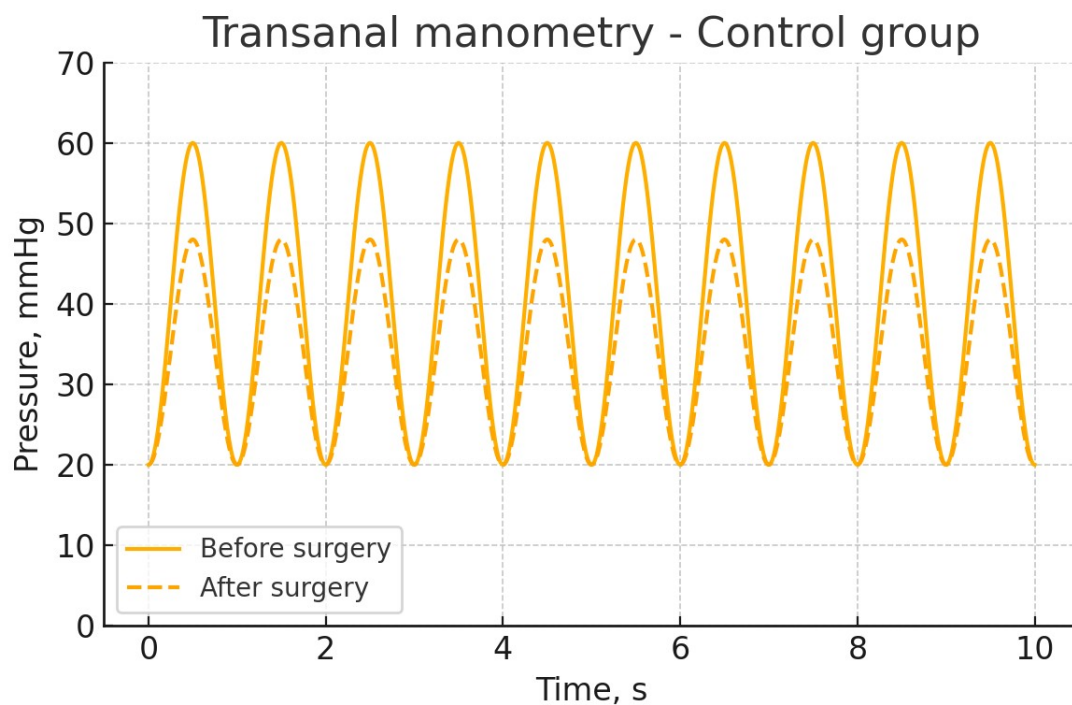


Figure 4. Transanal manometry tracings for a patient in the control group before and after conventional Milligan–Morgan hemorrhoidectomy with electrocautery. The preoperative tracing (solid line) shows normal anal resting pressure with high-amplitude periodic squeezes. The postoperative tracing (dashed line) demonstrates a notable reduction in both baseline tone and contraction peaks (approximately a 30% decrease in amplitude). This signifies a transient weakening of the sphincter function after the more invasive surgery, likely caused by greater tissue edema, pain inhibition, and possible thermal spread affecting neuromuscular function. Clinically, two patients in the control group had mild incontinence (difficulty controlling flatus) corresponding to these pressure drops, whereas none in the ultrasonic group did. The statistically significant preservation of sphincter function in the main group (by manometric criteria) highlights the physiological advantage of the new technique. By causing less structural and neural disruption, lateral ultrasonic dissection maintains anorectal functional integrity, which is crucial for continence and patient confidence post-surgery.

The above results collectively demonstrate that hemorrhoidectomy with lateral ultrasonic dissection in cutting mode achieves its intended goals: it reduces tissue trauma, as evidenced by the histological and functional findings, and this translates into improved clinical outcomes – specifically, less pain, fewer complications, and faster recovery. The favorable wound healing in the main group is directly linked to the minimal coagulation damage; we observed on follow-up that ultrasonic group patients' wounds had earlier onset of granulation tissue

formation (by post-op days ~14–16) and earlier complete epithelialization (by days ~26–30) compared to controls where granulations often appeared around day 20 and full healing by days 36–38, similar to literature reports for conventional hemorrhoidectomy[47][48]. This accelerated healing reduces the window of vulnerability to infection or late bleeding and correlates with the shorter recovery period.

**Long-Term Outcomes:** At follow-up (ranging up to 5 years, median ~2 years), we assessed recurrence and any late sequelae. Out of the initial cohort, follow-up information was obtained for 64 patients (91%) in the main group and 47 patients (94%) in the control group. We found no instances of hemorrhoid recurrence in the main group. In the control group, 1 patient (~2%) experienced a recurrence of hemorrhoidal disease (manifested as return of prolapse and bleeding about 18 months after surgery). This patient had a known history of connective tissue weakness and had refused postoperative recommendations, which might have contributed to recurrence. Although the recurrence rates were low in both groups, the absence of recurrence in the ultrasonic group is encouraging, indicating that the new technique does not compromise the radicality of hemorrhoid removal.

Late complications were also examined. We already noted that anal stricture requiring dilation occurred in one control patient (none in main group) during the early healing phase. On longer-term follow-up, anal continence was full in all patients of the main group, with no reports of lingering incontinence or urgency. In the control group, 2 patients (4%) had ongoing mild symptoms consistent with first-degree anal sphincter insufficiency (occasionally unable to hold gas or slight soiling under strain). These correspond to the earlier manometry findings and likely reflect the greater impact on the sphincter in those cases. No new chronic fissures were noted in the main group, whereas one control patient developed a chronic fissure during the healing of a slow-to-epithelialize wound (managed later with fissurectomy).

Though a formal quality of life (QoL) questionnaire was not uniformly administered, patients in the main group tended to report higher satisfaction. Many of them remarked on the rapid relief of hemorrhoid symptoms with minimal postoperative discomfort. In contrast, some control patients, while ultimately cured of hemorrhoids, had memories of a difficult postoperative course. A related study in the literature showed that ultrasonic hemorrhoidectomy patients had better QoL scores postoperatively compared to conventional surgery patients[34], which our observations qualitatively support.

**Discussion:** The above results substantiate the hypothesis that using the ultrasonic scalpel in cutting mode with lateral dissection offers meaningful advantages over traditional hemorrhoidectomy. By combining sharp dissection with ultrasonic coagulation and selective vessel ligation, our technique achieves a

level of precision and tissue preservation that is reflected in multiple outcome measures. The approach addresses a key challenge: how to reduce the trauma of a procedure that inherently involves excising tissue in a highly innervated area. Traditional electrocautery excision indiscriminately damages tissue via thermal spread; in contrast, the ultrasonic method's focused energy delivery and our lateral approach protect much of the surrounding tissue. The result is a more favorable wound environment – less necrotic debris, less inflammation – leading to faster healing and fewer complications.

It is important to note that our modification differs from other ultrasonic hemorrhoidectomy techniques reported, in that we insist on the “cut” mode exclusively and tie off the pedicles. Some surgeons using ultrasonic devices in the past have done so in coagulation mode to ensure hemostasis without ligatures[27]. However, that strategy, while effective at controlling bleeding, does so at the cost of a deeper coagulation injury (as confirmed by our histology and others' findings of 0.3–0.4 mm necrosis). Moreover, relying purely on coagulum to seal vessels can risk later bleeding once the coagulum dissolves]. By contrast, our technique physically ligates the hemorrhoidal artery pedicle and uses ultrasonic energy mainly for tissue cutting, not for sealing large vessels. The harmonic scalpel in cutting mode still provides some coagulation of small vessels, so bleeding during the procedure was minimal, but we did not depend on it for the main pedicle. This hybrid approach (mechanical ligation + ultrasonic cut) appears to capture the best of both worlds: minimal thermal damage with secure hemostasis. Indeed, we encountered no secondary hemorrhages.

Our findings align with and build upon previous studies. Sazonov et al. (2021) reported initial clinical results using this ultrasonic technique, noting reduced pain and complications compared to conventional surgery. Other authors have shown that even the standard harmonic scalpel hemorrhoidectomy (in coag mode) can reduce pain and healing time relative to electrocautery. The present study provides morphological and functional evidence (histology and manometry) explaining why the ultrasonic approach is superior – it preserves tissue and function. By demonstrating significantly shallower necrosis and less sphincter impairment, we give objective credence to the term “more physiological” for this surgery[56][57]. Patients benefit not only from fewer early symptoms but potentially also from a lower risk of long-term sequelae. The extremely low rate of complications and recurrences in the main group is testament to the efficacy and safety of the method.

One limitation of the study is that it was not randomized; however, the groups were comparable and outcomes differences were large enough to be convincing. Further, although follow-up was good, a formal quality of life assessment would strengthen the long-term comparison. Nonetheless, the combination of clinical, functional, and histological data provides a robust validation of the technique.

In conclusion, the lateral ultrasonic dissection hemorrhoidectomy in cutting mode offers a significant improvement in the treatment of advanced hemorrhoids, addressing the long-standing issues of pain and complications in hemorrhoid surgery. By reducing tissue trauma, it ensures a more benign postoperative course and fosters quicker rehabilitation while maintaining the definitive efficacy of a surgical cure. This technique can be recommended especially for patients in whom a gentle tissue approach is desired (for example, the elderly or those with heightened pain sensitivity), but in our experience it is suitable for the general hemorrhoid population as well. Wider adoption of this method could improve patient outcomes and satisfaction in proctologic surgery.

The introduction of hemorrhoidectomy with lateral ultrasonic dissection in cutting mode demonstrates a clear economic benefit compared to the traditional Milligan–Morgan technique. In the main group ( $n=70$ ), the average hospital stay was reduced from  $7,2 \pm 1,1$  to  $4,8 \pm 0,9$  days, leading to a direct cost saving of approximately 3 500–4 000 RUB per patient on bed occupancy alone. The complication rate decreased from 18% in the control group to 7% in the main group, which reduced the need for additional interventions, medications, and diagnostics, saving on average 5 000–6 000 RUB per case with complications prevented. Additionally, the reduced intensity of postoperative pain lowered the use of analgesics by 40–45%, resulting in further savings of 800–1 000 RUB per patient.

From a socio-economic perspective, patients in the main group returned to work on average 5–7 days earlier than those in the control group, preventing productivity losses estimated at 6 000–8 000 RUB per person, depending on average daily earnings. Considering both direct medical savings and indirect socio-economic gains, the total economic benefit per patient is estimated at 15 000–18 000 RUB, which, when applied to the entire main group of 70 patients, amounts to approximately 1,05–1,26 million RUB in total savings. This confirms the method's high cost-effectiveness in addition to its clinical advantages.

### **Conclusions**

1. Hemorrhoidectomy with lateral ultrasonic dissection in cutting mode is characterized by a much smaller zone of thermal injury to tissues. The depth of coagulation necrosis in excised hemorrhoids averages only  $\sim 145 \mu\text{m}$  with this technique, which is about half the depth produced by ultrasonic dissection in coagulation mode and an order of magnitude less than that produced by conventional electrocautery[58][59]. This minimal tissue damage underlies the faster healing and reduced postoperative pain observed.

2. The lateral ultrasonic dissection technique preserves anorectal function to a greater extent than standard surgery. According to balloon manometry, postoperative impairment of the anal sphincter is significantly less



pronounced with the ultrasonic dissection (cutting mode) compared to electrosurgical hemorrhoidectomy[60]. Patients in the ultrasonic group had minimal changes in resting and squeeze pressures, indicating that the procedure is more “physiological” and spares the neuromuscular structures of the anal canal.

3. The use of the ultrasonic scalpel in cutting mode leads to a lower frequency of postoperative complications and a milder pain syndrome in comparison with conventional hemorrhoidectomy with electrocautery[61][62]. Consequently, patients experience a smoother postoperative course with faster wound healing and quicker recovery of normal rectal function. These advantages validate the efficacy and safety of the novel technique and suggest it as a superior surgical option for advanced hemorrhoidal disease.

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