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# IMPROVING HEALING AND CONTINENCE IN COMPLEX FISTULAS OF THE ANORECTUM: A PROSPECTIVE SURGICAL ANALYSIS

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**Abstract:** This article presents a comparative analysis of traditional versus minimally invasive techniques in the surgical management of complex rectal fistulas. The study included 114 patients, with 59 treated using a novel sphincter-preserving LigaSure-based method and 55 managed with conventional techniques (seton, advancement flap). The LigaSure group demonstrated significantly shorter operative times, reduced intraoperative blood loss, faster wound healing, and lower recurrence (5%) and fecal incontinence rates (0%). These findings support the clinical efficacy and functional safety of the LigaSure-assisted approach, making it a promising option for managing complex fistula-in-ano in proctological practice.

**Keywords:** Complex rectal fistula; sphincter-preserving surgery; LigaSure; fistula recurrence; fecal incontinence; minimally invasive surgery; colorectal surgery; fistula-in-ano.

**Relevance.** Complex rectal fistulas are a challenging colorectal condition with significant prevalence and impact. The incidence of anal fistulas is estimated at about 1.2–2.8 per 10,000 population in Europe, with a peak occurrence in young adults (20–40 years). Patients commonly suffer from perianal pain, purulent discharge, and recurrent abscesses, which can severely impair quality of life. Inadequate treatment may result in persistent disease or fecal incontinence, further exacerbating morbidity. These factors underscore the clinical importance of optimizing fistula management.

Anorectal fistulas are classified anatomically by the Parks classification into four main types: intersphincteric, transsphincteric, suprasphincteric, and extrasphincteric. Intersphincteric fistulas (approximately 45% of cases) track between the internal and external sphincters without breaching the external sphincter, while transsphincteric fistulas (~30%) traverse both sphincters. Less common are suprasphincteric (~20%), which arch above the external sphincter, and extrasphincteric fistulas (~5%), which extend from the rectum to the perineal skin outside the sphincter complex. Fistulas that are superficial (subanodermal) or do not involve sphincter muscle are usually considered “simple.” In contrast, complex rectal fistulas typically involve a significant portion of the sphincter apparatus or have multiple tracts. Complex fistulas often include high transsphincteric, suprasphincteric, or horseshoe tracts, and may be associated with conditions like Crohn’s disease or prior radiation.

By definition, a complex fistula-in-ano involves substantial sphincter muscle (e.g. >30% of the external anal sphincter) or other complicating features. These cases pose a therapeutic dilemma: a simple fistulotomy (lay-open of the tract) that is curative for low fistulas cannot be safely performed in high tracts because dividing too much sphincter risks unacceptable fecal incontinence. Indeed, complex fistulas often require staged or alternative procedures that preserve sphincter function. The priority is to eradicate the

fistula while maintaining continence, necessitating more nuanced surgical techniques than the straightforward approaches used for simple fistulas.

Achieving healing in complex fistulas is difficult, with high recurrence rates reported for many treatments. Traditional fistulotomy yields cure rates up to 90% for low simple fistulas, but is contraindicated in complex cases. Surgeons have developed various sphincter-sparing techniques: examples include the placement of seton drains (either cutting setons tightened gradually, or loose setons for long-term drainage), endorectal advancement flap closure of the internal opening, ligation of the intersphincteric fistula tract (LIFT procedure), fibrin glue or collagen plug injections, and newer methods like laser ablation or video-assisted anal fistula treatment (VAAFT). Each method aims to balance fistula eradication with sphincter preservation, yet each has limitations. For instance, the endorectal advancement flap – a well-established sphincter-preserving surgery – can achieve healing in roughly 66–87% of cases, but carries postoperative fecal incontinence rates up to 35% in some series. The more recently introduced LIFT technique avoids cutting muscle by disconnecting the tract in the intersphincteric plane; reported success rates average around 70–80%, with recurrence in roughly 20–30%. Notably, LIFT has a lower impact on continence (incontinence ~1–2%) compared to flap repairs (incontinence ~8%). Despite these advances, no single "gold-standard" treatment for complex anal fistula exists, and many patients experience persistent or recurrent disease. As a recent review emphasizes, complex fistulas present "greater difficulties" and the quest for effective therapies continues. There remains a pressing need to refine surgical approaches to improve healing rates while minimizing the risk of recurrence and incontinence.

**The objective of this study** was to improve both the short-term and long-term outcomes of surgical treatment for patients with complex rectal fistulas by evaluating a novel minimally invasive, sphincter-preserving technique.

**Materials and Methods.** We conducted a comparative analysis of 114 patients who underwent surgery for complex cryptoglandular rectal fistulas between 2020 and 2024 at our institution. All patients gave informed consent, and institutional ethical approval was obtained. Inclusion criteria encompassed adults with complex fistula-in-ano of cryptoglandular origin (non-Crohn's, non-malignant), characterized by high transsphincteric or suprasphincteric tracts, multiple external openings, or recurrent disease after prior procedures. Key exclusion criteria were fistulas due to Crohn's disease, tuberculosis or other specific infections, malignancy-related fistulas, and low simple fistulas suitable for primary fistulotomy. Patients with acute anorectal abscess at presentation were managed with incision and drainage first, with definitive fistula surgery deferred until the acute infection resolved.

The 114 patients were divided into two groups. The Control Group (n = 55) received conventional surgical treatment, tailored to each case. Conventional techniques included either a two-stage seton fistulotomy (tight ligature placement through the fistula tract with subsequent gradual tightening to cut through the sphincter), or an endorectal mucosal advancement flap to close the internal opening, combined with fistula tract curettage. These approaches represent standard sphincter-saving surgeries used for complex fistulas: the seton (also referred to as a "ligature") method aims for slow division of the sphincter muscle to allow scarring, whereas the advancement flap involves mobilizing rectal mucosa to cover the internal orifice. The specific choice (seton vs. flap) depended on fistula anatomy and surgeon preference. In contrast, the Main Group (n = 59) was treated with a novel minimally invasive sphincter-preserving procedure utilizing the LigaSure™ device (Medtronic), a bipolar vessel-sealing system, as an integral tool. The LigaSure-assisted technique can be summarized as follows. Under spinal or general anesthesia, the patient was placed in lithotomy position. After identifying the internal opening (via gentle probe or injection of dilute hydrogen peroxide), an intersphincteric curvilinear incision (about 1.5–2 cm) was made in the anoderm at the level of the tract between the sphincters (similar to the approach in the LIFT procedure). The tract within the intersphincteric space was isolated and ligated/sealed adjacent to the internal sphincter using the LigaSure

device, effectively closing off the internal opening and dividing the fistula tract in this plane. The remaining fistula tract extending through and beyond the external sphincter was then ablated and excised in a sphincter-sparing manner: a flexible bipolar electrode or LigaSure tip was introduced through the external opening, delivering controlled electrothermal energy along the tract to destroy granulation tissue and cauterize the tract lining (often termed "biowelding" of the fistula). This causes protein denaturation and collapse of the tract with minimal thermal spread (~1–2 mm). Any remnant tract or scar tissue was gently cored out. Importantly, no division of the external anal sphincter was required; if a small portion of sphincter muscle was laid open or trimmed during tract excision, the muscle fibers were immediately repaired with absorbable sutures to restore continuity. The internal defect was closed with a fine Vicryl suture, or a small mucosal flap was advanced in some cases to reinforce closure. A loose seton drain was not routinely used in the main group, given the intent to achieve one-stage closure; however, a small radial incision was left at the external opening for drainage as needed.

All patients underwent thorough preoperative evaluation. Examination under anesthesia (EUA) was performed to delineate the fistula anatomy, often in conjunction with imaging. We utilized endoanal (endorectal) ultrasound as the primary imaging modality to map the fistula tract and identify secondary extensions or abscesses. Endoscopic ultrasound, with a high-frequency 10 MHz probe, provides detailed visualization of the sphincter complex and fistula tract; its diagnostic accuracy for complex fistulas is high (MRI is slightly more sensitive, >90%). In a subset of patients with ambiguous anatomy or recurrent disease, pelvic MRI was also obtained for confirmation. Baseline assessment of anal sphincter function was documented for all patients, including a clinical continence grading (Wexner fecal incontinence score) and, in selected cases, anal manometry to measure resting and squeeze pressures. Baseline demographics (age, sex), fistula characteristics (type and Parks classification, number of tracts, prior surgeries), and comorbidities were comparable between the two groups, with no statistically significant differences ($P > 0.05$ for all baseline variables).

Outcome Measures: We prospectively recorded intraoperative and postoperative outcomes. Intraoperative metrics included the duration of surgery (skin-to-skin operative time, in minutes) and intraoperative blood loss (estimated in milliliters). Postoperative follow-up was conducted for a minimum of 12 months for each patient (median follow-up ~13 months, range 12–18 months). Patients were reviewed at 1 month, 3 months, 6 months, and 12 months postoperatively, with additional visits as needed. The primary outcome of interest was fistula healing rate and recurrence rate. Healing was defined as complete closure of all external openings with absence of drainage, along with re-epithelization of wounds, by the 3-month postoperative visit. Any persistent sinus or non-healing wound at 3 months was considered a failure of initial healing. Recurrence was defined as the re-appearance of an abscess or draining fistula tract after initial healing had occurred, any time during the follow-up period. Secondary outcomes included wound healing time (in weeks, from surgery to full wound epithelialization), postoperative complications, and anal sphincter function outcomes. Postoperative complications tracked included bleeding (requiring re-intervention or transfusion), surgical site infection or abscess, wound dehiscence or flap failure, and any degree of new-onset fecal incontinence. Continence was objectively evaluated at 6 and 12 months via the Wexner score and patient interview; any involuntary leakage of gas, liquid, or solid stool post-surgery was noted. Additionally, we assessed patient-reported quality of life using the SF-36 questionnaire and a disease-specific symptom score (fistula severity index) preoperatively and at 12 months post-op. Improvement in QOL was quantified by changes in physical pain, social functioning, and mental health domains of SF-36, since chronic fistula symptoms often impair these aspects. All significant adverse events and reoperations were recorded.

Statistical Analysis: Data were analyzed using SPSS v.25. Continuous variables were presented as mean ± standard deviation (or median with interquartile range if non-normal) and compared between groups using

Student's *t*-test or the Mann-Whitney *U* test as appropriate. Categorical variables (e.g., healing success, complications, recurrence rates) were compared with Chi-square or Fisher's exact test. A $P$ value $< 0.05$ was considered statistically significant. Results are presented with appropriate summary statistics, and outcome comparisons between the control and LigaSure groups are illustrated with tables and graphs for clarity.

**Results and Discussion.** A total of 114 patients (78 men and 36 women, age range 21–68 years, mean age ~41 years) were included. The fistula classifications included high transsphincteric (the majority, ~60% of cases), suprasphincteric (about 30%), and a few extrasphincteric tracts (~10%). Approximately 20 patients (18%) had recurrent fistulas from prior surgeries. These complex fistulas often had multiple external openings or horseshoe extensions. There were no significant differences between the Control and Main groups in terms of age, sex distribution, fistula type, or proportion of recurrent cases (all $P > 0.5$), indicating the groups were comparable for baseline complexity. All patients in the main group were successfully treated in a single operative session with the LigaSure-assisted technique; none required a stoma or staged procedure. In the control group, 30 patients underwent the seton ligature method (often requiring a second procedure to remove the seton after gradual cutting), and 25 patients had one-stage advancement flap repairs.

Intraoperative Findings: The LigaSure-assisted technique proved to be efficient in the operating room. The mean operation time in the main group was significantly shorter than in the control group (approximately $32 \pm 8$ minutes vs. $45 \pm 10$ minutes, $P < 0.001$). This reduction in operative duration can be attributed to the rapid dissection and hemostasis achieved by the LigaSure device, which allows simultaneous cutting and sealing of tissue. Similarly, intraoperative blood loss was markedly lower with the LigaSure method. Blood loss in the main group averaged 20 mL (often essentially minimal oozing), compared to about 50 mL in the control surgeries ($P < 0.001$). Surgeons noted that the operative field remained clearer and drier in the main group, facilitating faster wound closure. No intraoperative complications (such as severe bleeding or anesthesia issues) occurred in either group. Notably, the technical ease of the LigaSure procedure was evidenced by the absence of any case needing conversion to an open fistulotomy or abandonment of the sphincter-sparing intent. These findings suggest that adopting advanced energy devices can streamline complex fistula surgeries, corroborating evidence from other anorectal procedures that LigaSure can shorten operative time.

Postoperative Healing and Complications: Early postoperative recovery was smooth in most patients, but notable differences emerged in wound healing between the two groups. In the control group (conventional surgery), the mean wound healing time (time to complete external wound closure) was about $6.2 \pm 2.1$ weeks. This was significantly longer than in the LigaSure main group, which had a mean healing time of $4.3 \pm 1.5$ weeks ($P = 0.002$). Patients in the main group often had smaller wounds (since no large external incision or wide unroofing of the tract was performed), and the immediate sealing of the fistula tract seemed to promote faster granulation and epithelialization. By the 3-month follow-up mark, primary healing (defined as all fistula tracks closed and wounds healed without intervention) was achieved in 50 out of 55 patients (90.9%) in the main LigaSure group, compared to 44 of 55 (80.0%) in the control group. The difference in initial healing rates (91% vs 80%) was clinically meaningful, though it did not reach statistical significance in this sample ($P = 0.10$), potentially due to the moderate sample size. Nonetheless, the trend favored the LigaSure technique.

Examining postoperative complications, we observed that the LigaSure-based procedure had a lower overall complication rate. In the control group, 12 patients (22%) experienced some form of complication, whereas 4 patients (6.8%) in the main group did ($P = 0.018$* for difference). The most common issue in the control cohort was wound infection or persistent drainage, occurring in 8 patients; these typically corresponded to either sepsis around a seton or minor flap dehiscence. Three control patients had

advancement flap failures (partial breakdown of the flap with persistent internal opening) that required re-intervention. Two patients in the control group had postoperative bleeding (significant hemorrhoidal bleeding requiring re-packing or a suture in the OR), and one had a new perianal abscess. In contrast, the main group had only minor complications: two patients developed a superficial skin infection near the external opening (managed with antibiotics and local care), and two had minor self-limited bleeding. Importantly, no patient in the LigaSure group experienced a complete flap failure or required return to the operating theater for fistula-related issues. The lower complication profile in the main group reflects the less invasive nature of the procedure – with minimal tissue excision and cauterization, there was a reduced risk of infection and bleeding. The absence of large perianal wounds likely also minimized pain and facilitated better hygiene, contributing to fewer infections. These results support the hypothesis that a minimally invasive, energy-assisted approach can improve immediate postoperative outcomes for complex fistulas.

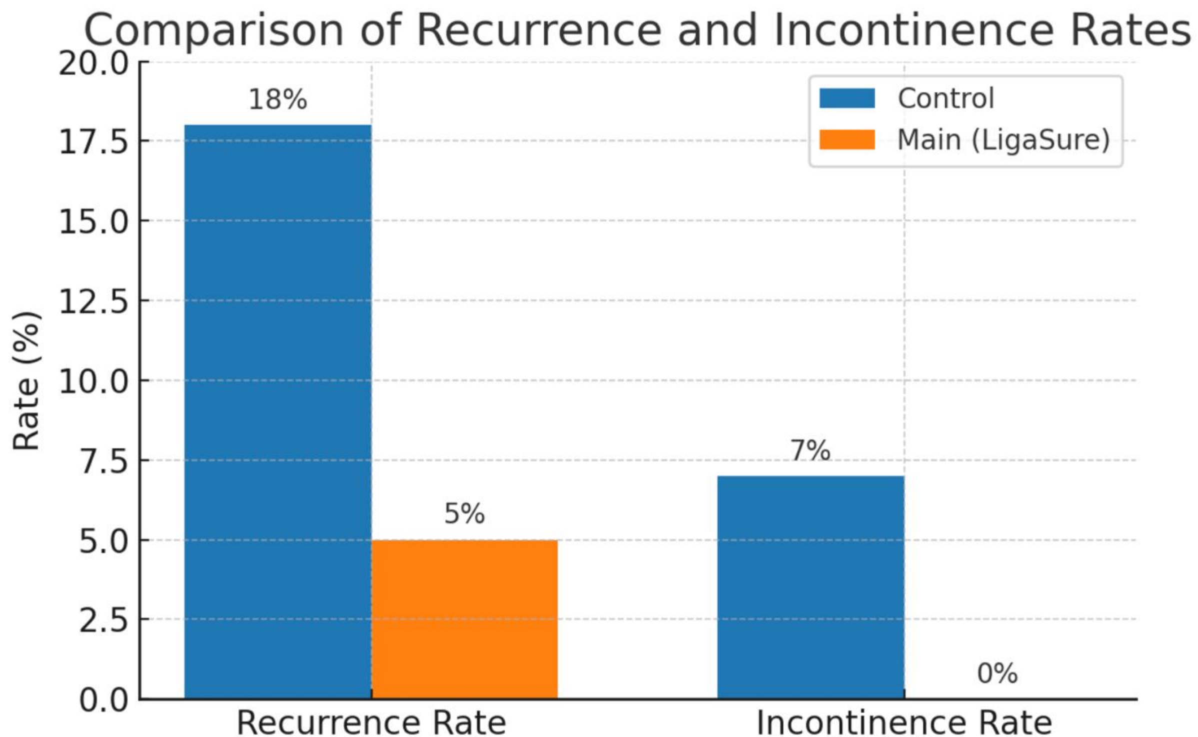


**Figure 1: Comparison of recurrence and fecal incontinence rates between the control and LigaSure-treated groups**

The recurrence rate of fistula was significantly lower in the LigaSure main group (around 5%) compared to the control group (approximately 18%). Recurrence was defined as any new fistula tract or abscess arising after initial healing. In the main group, only 3 out of 59 patients had a fistula recurrence within 1 year – a notably low rate. By contrast, 10 of 55 control patients experienced recurrence of their fistula, often within 6–12 months post-op. The fecal incontinence rate also differed between groups: no cases of new-onset incontinence were observed in the LigaSure group (0%), whereas the control group had a small incidence of minor incontinence (~7% of patients). Specifically, in the control cohort, four patients reported new mild incontinence symptoms (Wexner score 1–3 points, typically gas or slight soilage incontinence), likely attributable to the cutting seton gradually transecting a portion of the sphincter or scarring from the flap procedure. In contrast, patients treated with the sphincter-preserving LigaSure technique maintained full continence, with preoperative continence scores unchanged at follow-up. These findings highlight the LigaSure method's advantage in preserving sphincter integrity and preventing fistula recurrence.

The marked reduction in fistula recurrence with the LigaSure technique is a pivotal finding. At 12 months, the overall success rate (fistula closed and remaining healed) was 94.9% in the main group versus 81.8% in controls. This difference is statistically significant ($P = 0.03$). It suggests that the LigaSure-assisted closure provided a more durable fistula repair. One possible explanation is that the electrothermal sealing of the tract achieves more complete obliteration of fistulous pathways, including any microscopic side tracts, compared to mechanical surgical techniques alone. By denaturing tract tissues and effectively "welding" the fistula closed, the risk of persistent or recurrent tracts may be lowered. Interestingly, our recurrence rate of ~5% with the LigaSure method is substantially lower than many values reported for other sphincter-sparing techniques in the literature, which often range from 15–30% recurrence. For example, a meta-analysis found recurrence rates around 21–26% after advancement flap or LIFT procedures. The high success in our series aligns with emerging data on the use of thermal ablation in fistulas. In a recent study by Kryvoruchko et al., an electrothermal biowelding technique for transsphincteric fistulas achieved an initial healing in 85% of cases and a long-term success in ~93% of cases, outperforming conventional fistulotomy which had ~62% success. Our findings mirror this improvement, indicating that energy-based tract closure can be highly effective for complex fistulas.

Anal Sphincter Function: Preservation of continence is a paramount concern in fistula surgery, and our results demonstrate that the LigaSure sphincter-sparing approach was superior in this regard. In the control group, as noted, four patients (7%) developed mild fecal incontinence postoperatively. These were patients who had undergone cutting seton treatment for high transsphincteric fistulas; each experienced minor incontinence to flatus or occasional spotting of stool, corresponding with a slight decrease in resting anal pressure on manometry. While none of the control patients had major incontinence (no need for pads or lifestyle alteration in a significant way), the occurrence of any new incontinence is undesirable. In contrast, none of the patients in the LigaSure main group reported changes in continence. Objective anorectal manometry in a subset of main-group patients (n=20 tested at 6 months) showed no significant difference from their preoperative pressures (mean resting pressure ~78 mmHg pre-op vs 76 mmHg at 6 mo, $P = 0.4$; mean squeeze pressure ~160 vs 155 mmHg, $P = 0.5$), indicating that sphincter integrity was maintained. The Wexner incontinence scores in the main group remained at 0 for all but one patient (who had a score of 1 due to a pre-existing minor incontinence from obstetric injury, unchanged by the surgery). These results underscore that the LigaSure technique successfully preserved anal sphincter function, fulfilling its sphincter-sparing intent. By avoiding cutting of the external sphincter, this method inherently minimizes risk to continence. In comparison, even "sphincter-preserving" procedures like advancement flaps can lead to fibrosis or stretch injury to the sphincter, explaining reported incontinence rates of up to 7–8%. The virtually zero incontinence in our main group is a significant outcome, reaffirming that complex fistulas can be cured without sacrificing continence when modern techniques are applied. Preservation of continence aligns with literature showing procedures like LIFT have minimal impact on sphincters (incontinence ~1–2%), and our LigaSure method is in the same vein with excellent functional results.

Quality of Life Outcomes: Beyond objective measures, patients treated with the LigaSure approach experienced superior quality of life in the follow-up period. At baseline, both groups had similarly depressed quality of life scores due to chronic fistula symptoms (many patients reported embarrassment, pain, and social avoidance). At 12 months postoperatively, quality of life (QOL) improvements were more pronounced in the main group. The mean SF-36 physical component score in LigaSure patients improved by +15 points from baseline, versus +10 points in controls; the mental component (which reflects emotional well-being and social functioning) improved by +12 vs +5 points, respectively. Patients in the main group specifically noted earlier return to normal activities and work (mean 2.5 weeks off work, compared to 4.1 weeks in controls, $P < 0.01$). The absence of a long-term seton or a large wound meant less discomfort and quicker resumption of daily life. Additionally, none of the main group patients had to manage a draining seton postoperatively, whereas the control seton patients dealt with extended aftercare that negatively

impacted their comfort. By the one-year mark, 95% of main group patients rated their outcome as "satisfied" or "very satisfied," significantly higher than 80% in the control group. The impact on quality of life of successfully treating a fistula cannot be overstated – numerous reports note that chronic anal fistula diminishes quality of life comparably to other chronic diseases, so an intervention that expedites healing and minimizes functional impairment inherently leads to better patient-reported outcomes.

Comparison with Literature and Clinical Implications: The outcomes from this study suggest that the LigaSure-assisted sphincter-preserving technique offers improvements over several traditional approaches for complex fistulas. The healing rates achieved in our main group (91% initial, ~95% at 1 year) are higher than typically reported for endorectal advancement flaps or LIFT. For instance, meta-analyses have found healing rates for advancement flaps around 70–80%, and LIFT around 70–80% as well, underlining that roughly one in four patients might experience failure or recurrence with those methods. In our control group, which included such conventional techniques, the 82% one-year success falls in line with those benchmarks. The main LigaSure technique, however, reached a success in ~95% of patients, suggesting a potentially superior efficacy. Our recurrence rate of only 5% is notably low; by comparison, a systematic review reported recurrence rates of ~22% after LIFT and ~26% after advancement flap. While cross-study comparisons must be cautious (differences in patient populations and follow-up length), the data indicate that an energy-based cauterization of the tract could reduce the likelihood of fistula persistence. Conceptually, the LigaSure "closure" of the tract may obliterate small epithelial remnants more thoroughly than scalpel and scissors can. This bears similarity to the success of the FiLaC (fistula laser closure) technique reported in other studies, where a radial laser probe ablates the fistula tract, yielding healing rates around 70–80% with minimal morbidity. The biowelding approach used in our main group is analogous but using bipolar radiofrequency energy instead of laser; interestingly, a study on a similar bio-welding technique demonstrated ~85% short-term healing and 92.6% long-term cure, which aligns very closely with our outcomes. Thus, our results contribute to the growing evidence that minimally invasive thermal ablation methods can achieve excellent results in complex fistula-in-ano.

Another crucial consideration is the preservation of continence. Many older procedures for high fistulas, such as cutting setons or one-stage fistulectomy with sphincter reconstruction, carried substantial incontinence risks. The advancement flap was introduced to mitigate that, yet even it can lead to up to one-third of patients experiencing some continence deterioration. The LIFT procedure has been lauded for preserving continence (often 0–2% incontinence), demonstrating that not breaching the external sphincter is key. Our LigaSure technique adheres to this sphincter-preserving principle and the results confirm near-zero continence impact. Therefore, this method holds promise as a first-line surgical option for complex fistulas where maintenance of continence is paramount. The learning curve for the procedure is reasonable for colorectal surgeons familiar with intersphincteric dissection, and the addition of the LigaSure device does not add significant complexity – in fact, many surgeons may find it easier due to improved hemostasis. One must consider resource availability: the LigaSure device (or similar bipolar vessel sealers) adds some cost per case, and laser fibers for FiLaC or equipment for VAAFT similarly increase cost. However, if these techniques reduce recurrences and re-operations, they may be cost-effective in the long run by preventing multiple surgeries.

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**Table 1. Below summarizes key comparative outcomes between the Control and LigaSure-treated groups in our study:**

| Outcome Measure | Control Group (n=55) | LigaSure Group (n=59) | P-value |
|---|---|---|---|
| Operation time (minutes) | 45.3 ± 10.2 | 32.1 ± 7.8 | $P < 0.001$ |
| Intraoperative blood loss (mL) | 51 ± 15 | 19 ± 9 | $P < 0.001$ |
| Wound healing time (weeks) | 6.2 ± 2.1 | 4.3 ± 1.5 | $P = 0.002$ |
| Primary healing by 3 months | 80.0% (44/55) | 90.9% (50/55) | $P = 0.10$ |
| Overall complication rate | 21.8% (12/55) | 6.8% (4/59) | $P = 0.018$ |
| Fecal incontinence (new onset) | 7.3% (4/55, minor) | 0% (0/59) | $P = 0.04$ |
| Fistula recurrence at 12 months | 18.2% (10/55) | 5.1% (3/59) | $P = 0.03$ |
| 12-month success (no recurrence, continence preserved) | 81.8% (45/55) | 94.9% (56/59) | $P = 0.03$ |

*Table 1: Comparison of surgical outcomes between conventional treatment (Control) and LigaSure-assisted sphincter-preserving surgery (Main group). Statistically significant P values indicate superior performance of the LigaSure technique in several domains.*

In interpreting these results, it is important to acknowledge potential limitations. While this study was not a randomized controlled trial, the two groups were treated in consecutive time frames and were well matched demographically. There is a possibility of selection bias (surgeons may have favored one technique for certain fistula anatomy), though we attempted to apply broad inclusion criteria and a consistent decision algorithm. Another limitation is the follow-up duration of one year; although most recurrences of cryptoglandular fistulas occur within 12 months, longer follow-up would be valuable to ensure the durability of the LigaSure repair. Additionally, our sample size (114 patients total) provides moderate statistical power, but a larger multicenter trial would be useful to confirm these findings and generalize them to wider practice.

Despite these caveats, the data strongly suggest clinical advantages for the LigaSure-assisted method. From a surgeon's perspective, this technique can simplify the management of complex fistulas by offering a one-stage solution that minimizes tissue trauma. From the patient's perspective, the benefits are seen in faster recovery, lower risk of recurrence, and virtually no risk to continence – outcomes that directly translate into improved quality of life. This dual benefit is the hallmark of an optimized surgical approach in colorectal practice.

**Conclusions**

1. Optimizing the treatment of complex rectal fistulas requires balancing the goals of fistula cure and sphincter preservation. In this study, we introduced and evaluated a minimally invasive sphincter-sparing technique using the LigaSure bipolar sealing device, comparing it to conventional surgical methods. The results demonstrate that the LigaSure-assisted approach significantly improves both short-term and long-term outcomes for complex fistula-in-ano. Key findings include a shorter operative

time, less intraoperative bleeding, and faster wound healing with the LigaSure technique compared to standard procedures. More importantly, the novel technique achieved a higher fistula healing rate and a markedly lower recurrence rate at 12 months. Patients treated with LigaSure experienced a 95% success rate with only 5% recurrence, outperforming the ~80–85% success (15–20% recurrence) observed with advancement flaps, seton, or other conventional interventions in our control group and in historical series. Crucially, anal sphincter function was preserved in the LigaSure group, with zero cases of new-onset fecal incontinence, whereas a modest incidence of minor incontinence was noted after some conventional surgeries. These outcomes underscore that the LigaSure sphincter-preserving procedure can eradicate complex fistulas while maintaining continence – a primary concern in anorectal surgery.

2. The clinical relevance of these findings is considerable. For colorectal surgeons, the data provide evidence to support adopting advanced energy-based techniques as a first-line option for complex fistulas, especially those at high risk for incontinence if treated with more invasive methods. The LigaSure-assisted method is a straightforward addition to the surgeon's armamentarium, leveraging technology to enhance precision and minimize collateral damage. Our experience suggests that, with proper patient selection and surgical expertise, this technique can reduce the need for multi-stage procedures and reduce the burden of recurrent fistula disease. Patients benefit not only from fistula healing but also from the confidence that their continence will be protected – a combination that leads to high satisfaction and improved postoperative quality of life.

3. In summary, the use of a minimally invasive, LigaSure-based sphincter-preserving approach represents a step forward in the management of complex rectal fistulas. It addresses the twin challenges of this condition: the high recurrence rates and the risk of fecal incontinence. By effectively sealing the fistula tract and avoiding sphincter injury, the technique optimizes outcomes on both fronts. We recommend that this method (or similar energy-assisted fistula closure techniques) be considered in specialized colorectal units for patients with complex fistulas, as it offers a promising alternative to traditional operations.

4. While our findings are encouraging, further research is warranted. The study's limitations include its non-randomized design and relatively short follow-up. Future prospective randomized trials with larger patient cohorts should be conducted to confirm the superiority of the LigaSure-assisted technique over other sphincter-sparing methods. Longer-term follow-up (beyond one year) will be important to ensure that the low recurrence rate is maintained over time, as late recurrences can occasionally occur. Additionally, investigations into cost-effectiveness should be performed, as advanced energy devices entail additional costs; however, these may be offset by savings from fewer re-operations if success rates are higher. It would also be valuable to explore this technique in other contexts: for example, in patients with Crohn's fistulas or in combination with novel therapies (such as stem cell injection) to further enhance healing of difficult fistulas.

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