

A Dual-Approach Strategy for Pilonidal Sinus Management: Limberg Flap Reconstruction with Adjuvant Diode Laser Epilation; A Case Series Evaluating Recurrence and Outcomes

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ABSTRACT

Objective: To evaluate recurrence rates, healing outcomes, and patient satisfaction following Limberg flap reconstruction combined with diode laser hair removal in individuals with primary pilonidal sinus disease.

Methodology: This prospective, single-center case series was conducted at the Department of Surgery, Nishtar Medical University and Hospital, Multan, between January 2023 and April 2025. Forty-nine patients aged 16 to 45 years with clinically confirmed primary pilonidal sinus were treated with standardized rhomboid excision and Limberg flap closure. Diode laser epilation was initiated after wound healing and repeated in four sessions. Data on recurrence, healing time, complications, pain scores, and satisfaction were collected at regular follow-up intervals for up to 24 months.

Results: The cohort included 46 males and 3 females (mean age: 29.9 ± 8.5 years). Over half were obese, and 71% reported sedentary work. Most patients (89.8%) had chronic symptoms exceeding 6 months. Flap necrosis occurred in 2 patients (4.1%), while wound infection and dehiscence were seen in two cases each. Mean time to epithelialization was 21 ± 2.3 days, with routine activities resumed in 22.6 ± 2.5 days. Pain scores declined progressively over the first postoperative week. One patient (2.0%) experienced recurrence at 18 months, yielding a 24-month recurrence-free rate of 97.9%. Compliance with laser sessions was high (81.6%), and 91.8% of patients reported satisfaction with treatment.

Conclusion: Limberg flap surgery combined with diode laser hair removal appears to be a well-tolerated and effective method for treating primary pilonidal sinus disease. This approach may offer improved outcomes in high-risk individuals, particularly in regions with limited long-term follow-up capacity.

Keywords: Pilonidal sinus, Limberg flap, laser epilation, recurrence, surgical outcome, Pakistan

Introduction

Pilonidal sinus disease (PSD) is an inflammatory condition that is chronic and which takes place in the sacrococcygeal area predominantly in young adult males. It is marked by the development of sinus tracts and recurrent abscess which are normally accompanied by pain, periodical or persistent purulent discharge, and swelling. The disease has a vast negative influence on the quality of life and is often associated with an inactive lifestyle, obesity, hirsutism, and unfavorable personal hygiene practices. The incidence is reported to be about 26 per 100,000 person-years though this could be lower because of underreporting in developing areas.¹ PSD is believed to be an acquired disease and the pathogenesis is believed to commence with the

invasion of hair shafts into the tissue beneath the skin by distended or broken hair follicles particularly in the cleft of the natal canal deep. This causes an inflammatory response of the foreign-body, resulting in the formation of sinus tracts and secondary infection.²

The literature has outlined various modalities of treatment, which have ranged between conservative management and minimal invasive and wide excision-based management of surgical procedures. Nevertheless, surgery is the foundation of absolute cure. Out of the available surgical procedures, the midline primary closure procedures have been abandoned because of the high incidences of wound complications and

recurrence of the disease. Reconstructions based off-midline flaps like the Limberg flap and Karydak procedure have increased in popularity because of better outcomes (e.g. faster healing time and reduced recurrence rates).^{3,4} Limberg flap operation is associated with rhomboid resection of the sinu and transsection of a fasciocutaneous flap of the surrounding gluteal tissue, which basically flattens the natal cleft and shifts the incision line off center, minimizing the tension on the wound and local moisture build-up, which are the risk factors of the recurrence.⁵

Although the advantages of flap techniques are obvious, there is still a problem of recurrence. Hair regrowth in the natal cleft after the operation is one of the recurring factors of contribution, that is likely to cause reinfection and new sinus development. Adjuvant therapies like laser hair removal have been tried to solve this. Diode laser epilation is based on the ability of the laser to strike melanin on hair follicles causing selective photothermolysis resulting in permanent hair loss. It is also said to be safe and effective even in darker skin type (Fitzpatrick IV- VI) where conventional laser systems have greater risks of pigment alteration and burns.^{6,7} Laser therapy is an intercessive and slight intervention technique that can be used when the wound is fully healed to decrease the risk of repetitive follicular blockage and inflammation.

Despite the shown positive results in the research of western countries where the use of the diode laser epilation along with surgical excision has shown improved results, there is a lack of data regarding the region and South Asia in particular where pilonidal sinu is underreported and in many cases is treated using the outdated methods. Such factors may include cultural aspects, low awareness and inability to receive postoperative laser therapy which results in recurrence and patient dissatisfaction.^{8,9}

It is in this sense that the current research was carried to examine the long-term clinical outcome, such as recurrence, healing time, postoperative complications, and patient satisfaction, in people undergoing primary PSD surgery using Limberg flap reconstruction, followed by diode laser hair removal in one tertiary care unit in Pakistan.

Methodology

It was a prospective, descriptive, single-arm case series that was carried out in the Department of Surgery and plastic surgery Pak Italian burn center at Nishtar Medical University and Hospital, Multan, in the period between January 2023 and April 2025. There were 49 randomly selected patients with clinically diagnosed primary pilonidal sinu disease (PSD). The diagnosis was made on the existence of one or more sinus openings in the sacrococcygeal area, which is accompanied by chronic purulent discharge or recurrent occurrence of localized abscesses. The inclusion criteria included patients aged between 16 and 45 years, having no previous surgical procedures on PSD, and Fitzpatrick Skin types I-VI. Patients were not included in case they had acute abscesses that needed emergency drainage, uncontrolled diabetes mellitus (HbA1c >8%), any known immunocompromised disease, or active dermatologic infections in the area of solution.

Informed consent was given in either Urdu or native language of the patient after receiving a structured counseling that consisted of the description of the surgical and laser procedures, anticipated outcomes, possible risks, and the follow-up schedule. All patients were offered a 24-hour period of decision before enrollment. In the case of participants under the age of 18 years, written consent and parental consent were taken.

IRB was obtained from Nishtar Medical University and Hospital in Multan. All the study was performed in the Helsinki and institutional ethical standards.

All patients that were enrolled were operated by one team of single experienced consultants with the Limberg flap technique. The process was characterized by broad rhomboid resection of all the involved tissue and sinu tracts to the presacral fascia. An adjacent portion of gluteal tissue was lifted to form a fasciocutaneous flap and superimposed over the defect in a length to width ratio of 1:1.5 to ensure tension free closure. The closed-suction drains (10 French) were selectively inserted, when the surgical dead space was more than 3 cm 3 and were removed when the drain output decreased to less than 30

mL in 24 hours. After surgery, the intravenous cefazolin (1 gram) was used together with analgesics in the form of paracetamol (1 gram) with tramadol (50 mg) and were given to all patients as a trio three times per day. Wound observations were done on a daily basis until the wound had full epithelialization, which was determined as intact dry skin with discharge absent.

The adjuvant diode laser epilation (810 nm wavelength) was started about three weeks after operation when it was clinically confirmed that wound healing was occurring. The patients were to undergo four laser treatments to be conducted at an interval of 3 to 4 weeks. The parameters of the treatment were dependent on the skin type and were 30-48 J/cm², 15-24 milliseconds pulse duration, and 9x9 mm spot area with 10 per cent overlapping pulses and chilled sapphire tip cooling (40°C) to reduce skin irritation. Conservative settings were used to treat Fitzpatrick type IV through VI skin to minimize the possibility of post-inflammatory pigmentation. The trichoscopy (20x magnification) was used to measure the density of the hair at baseline and at the 24-month follow-up. A decrease of 50 percent or more in the visible follicular density was considered as clinical significance of hair reduction.

Those patients who completed at least three out of the four scheduled laser sessions were classified as compliant. Missed appointments were also reminded through SMS and telephone calls.

The first effect was the reoccurrence of pilonidal sinus disease 24 months after the operation. The recurrence was determined as the clinical manifestation of a new sinus tract, purulent discharge, swelling or abscess development at or near the initial surgical site after reported full healing. Two surgical consultants, independent of each other, confirmed each suspected recurrence.

The time to complete wound healing (in days since surgery to epithelialization), postoperative pain levels using Visual Analogue Scale (VAS) on days 1, 3 and 7 and the days it took the patient to resume normal daily functioning were secondary outcomes. Postoperative complications were counted based on Clavien-Dindo classification grade 2 and above. The patient satisfaction was measured based on a 5-point Likert scale

performed at the 12- and 24-month follow-ups. Moreover, the efficacy of hair reduction was determined according to trichoscopic findings.

The following variables were taken as the baseline during the enrollment stage: age, sex, body mass index (BMI), smoking status (defined as ≥ 1 cigarette/day), number of sinus tracts, and weeks of symptoms. Occupation (sedentary category in which one is sitting more than 6 hours/day) and hygiene practices (daily and intermittent cleansing) were also noted as confounding variables.

Follow-up of patients was done after 1, 3, 6, 12, 18 and 24 months after surgery. Clinical evaluation covered examination of the surgery site, complications determination, recurrence evaluation and standardized digital photography. In the cases with an unclear clinical presentation or clinical recurrence, ultrasound imaging was used.

Among the 49 patients who were enrolled, 40 (81.6%) had 24 months follow-up. The rest of the patients were not followed after 18 months, five out of five after 12 months as well as one that dropped out after receiving two laser sessions only by the sixth month of the postoperative. There were no further incidences reported in patients that failed to have the complete follow-up.

All data were recorded on a structured proforma and put into the SPSS version 25 to be analyzed. The continuous variables (e.g., wound healing, pain scores, etc.), were reported as mean with standard deviation (SD), and the categorical variables (e.g., rates of complication, recurrence, compliance, etc.) were reported as frequencies and percentages. The Kaplan-Meier survival analysis was used to estimate recurrence-free survival. Since the study was descriptive, no inferential statistics tests were used. Complete-case analysis was used to deal with missing data that covered less than 10% of records. Operational definitions and variable classifications are presented in Table I.

Table I: Operational Definitions and Classification of Study Variables.				
Variable	Operational Definition	Scale/Unit	Measurement Method	Classification
Age	Chronological age at time of surgery, calculated from date of birth	Continuous (years)	Patient medical record	Independent Variable
Gender	Self-reported biological sex	Categorical (Male/Female)	Direct inquiry at time of enrollment	Independent Variable
Body Mass Index (BMI)	Weight in kilograms divided by height in meters squared	Continuous (kg/m ²)	Calibrated scale and stadiometer	Independent Variable
Smoking Status	Current use of tobacco products, self-reported	Binary (Yes/No)	Patient self-report	Confounding Variable
Occupation Type	Degree of physical activity in daily occupation	Categorical (Sedentary/Active)	Job description based	Confounding Variable
Fitzpatrick Skin Type	Classification of skin based on pigmentation and sun response	Ordinal (Type I–VI)	Visual assessment	Confounding Variable
Duration of Symptoms	Time from symptom onset to surgery	Continuous (weeks)	Patient history	Independent Variable
Number of Sinus Tracts	Count of distinct sinus openings	Discrete count	Clinical exam/pre-op record	Independent Variable
Preoperative Infection	Erythema, discharge, or cellulitis	Binary (Present/Absent)	Clinical evaluation	Confounding Variable
Surgical Duration	Operating time from incision to closure	Continuous (minutes)	Operating room records	Independent Variable
Drain Placement	Closed-suction drain used intraoperatively	Binary (Yes/No)	Operative notes	Independent Variable
Flap Necrosis	Partial/full-thickness necrosis of Limberg flap	Binary (Present/Absent)	Postoperative exam	Dependent (Complication)
Wound Infection	Redness, discharge, or fever post-op	Binary (Present/Absent)	CDC SSI criteria	Dependent (Complication)
Wound Dehiscence	Separation of wound edges	Binary (Present/Absent)	Clinical inspection	Dependent (Complication)
Time to Complete Wound Healing	Days until full epithelialization	Continuous (days)	Follow-up clinical assessment	Dependent Variable
Postoperative Pain (VAS Score)	Pain score on VAS at days 1, 3, 7	Ordinal (0–10)	VAS scale	Dependent Variable
Time to Return to Routine Activity	Days until normal activity resumed	Continuous (days)	Patient self-report	Dependent Variable
Recurrence of Pilonidal Disease	New tract/discharge/abscess post-healing	Binary (Yes/No)	Follow-up exam	Primary Dependent Variable
Laser Session Compliance	Number of laser sessions completed	Complete/Partial/Non-compliant	Laser logs	Effect Modifier/Confounding
Patient Satisfaction	Satisfaction score at 12/24 months	Ordinal (1–5 Likert Scale)	Patient questionnaire	Secondary Dependent Variable

Results

The study included 49 patients with a mean age of 29.9 ± 8.5 years (range: 16–45), predominantly male (93.9%) and mostly under 30 years of age (55.1%). Over half were obese (51.0%), followed by overweight (30.6%) and normal BMI (18.4%). Most participants were smokers (38/49) and had sedentary occupations (35/49), while Fitzpatrick skin types were mainly V and VI. (Table II)

Table II: Baseline Characteristics Summary.	
Variable	Summary
Age (years)	29.9 ± 8.5 years
Gender	{'Male': 46, 'Female': 3}
BMI Category	{'Obese': 25, 'Overweight': 15, 'Normal': 9}
Smoking Status	{'Smoker': 38, 'Non-Smoker': 11}
Occupation Type	{'Sedentary': 35, 'Active': 14}
Fitzpatrick Type	{'V': 17, 'VI': 16, 'IV': 16}

Figure 1 shows the distributions of the BMI categories.

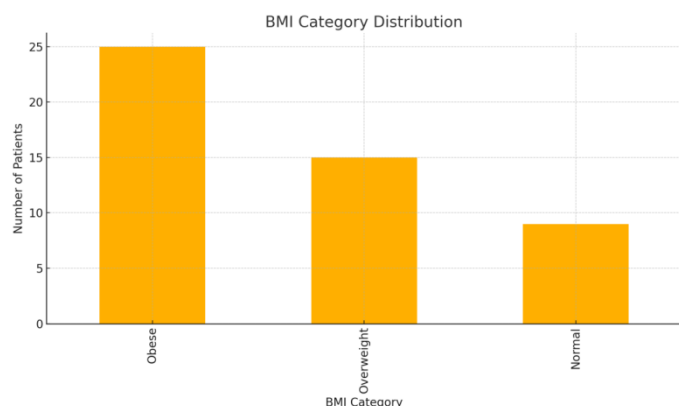


Figure 1. BMI Category Distribution.

Patients who were current smokers numbered 38 (77.6%), while 35 (71.4%) reported sedentary occupations (>6 hours/day). Fitzpatrick skin types were evenly distributed: Type IV (n = 16, 32.7%), Type V (n = 17, 34.7%), and Type VI (n = 16, 32.7%). The mean duration of symptoms prior to presentation was 11.2 ± 3.1 months, and 44 (89.8%) patients had a chronic disease course (>6 months). Most patients had two sinus tracts (n = 32, 65.3%), while 9 (18.4%) had one and 8 (16.3%) had three. Preoperative infection was present in 44 (89.8%) cases and resolved with oral antibiotics prior to surgery.

The mean operative time was 75 ± 9 minutes (range: 60–90), and all patients received a 10Fr closed-suction drain, typically removed on postoperative day 3 once output was <30 mL/24h, followed by discharge without readmission or early complications.

Flap necrosis occurred in 2 (4.1%) patients (one superficial and one partial), wound infection in 2 (4.1%), and wound dehiscence in 2 (4.1%); all were managed conservatively or with minor intervention without major reoperation. Mean wound healing time was 21 ± 2.3 days (range: 16–26), and mean time to recurrence (when applicable) was 22.6 ± 2.5 months. Postoperative pain scores showed a steady decline (VAS 6.2 ± 1.1 on day 1, 5.4 ± 1.2 on day 3, and 4.6 ± 1.0 on day 7). (Figure 2)

There was one recurrence (2.0%) at 18 months, successfully managed with minor excision and secondary healing, yielding a recurrence-free survival of 97.9% at 24 months. Adherence to adjuvant laser therapy was high, with 40 (81.6%)

patients completing all four sessions. Patient satisfaction was high overall, with 30 (61.2%) reporting very satisfied, 15 (30.6%) satisfied, 3 (6.1%) neutral, and 1 (2.0%) unsatisfied. (Figure 3)

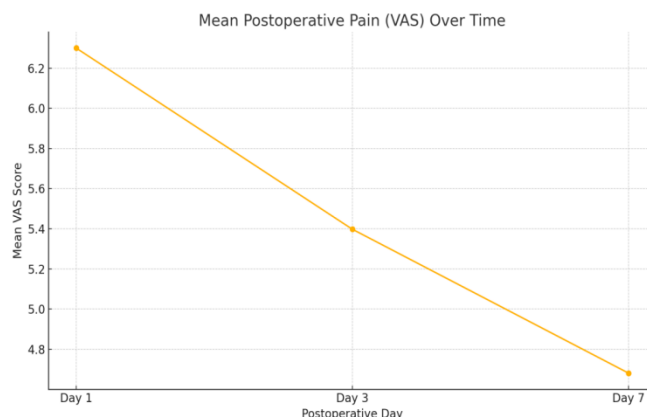


Figure 2. Mean Postoperative Pain (VAS) Over Time.

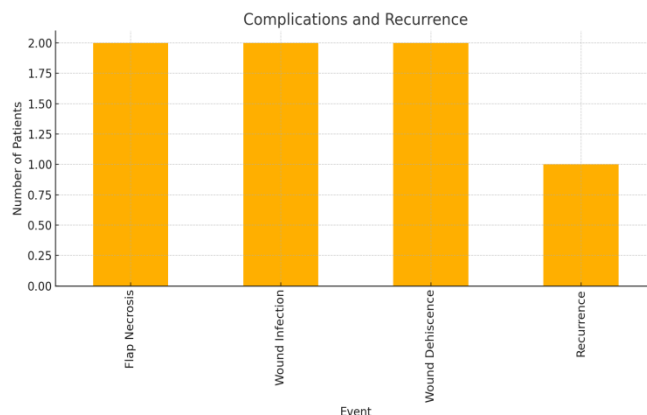


Figure 3. Complications and Recurrence

Discussion

The present prospective case series demonstrates the positive results of Limberg flap reconstruction with adjuvant diode laser hair removal as the management of the primary pilonidal sinu disease (PSD). Out of 49 treated patients, one had recurrence within a period of 24 months hence a recurrence rate of 2.0. These results indicate that such a dual-modality method could be useful in preventing recurrence of the diseases and especially in patients who are already known to have risk factors like obesity, sedentary lifestyle and Fitzpatrick skin types IV-VI.¹⁰⁻¹²

The recurrence rate of this study is not as high as the literature reported rate regarding Limberg flap procedures alone whereby the recurrence is generally between 5 and 10 percent even when

using off-midline closure.^{13,14} This distinction can be explained by the laser element, which is focused on remaining hair follicles in the intergluteal area, a well-known etiological risk of PSD occurrence.^{15,16,17} These findings are also consistent with those of Oram et al. and Dessy et al. who reported an increase in the recurrence rates with diode laser hair removal added to the conventional surgical practice.¹⁸

The 21 days of recovery and the fact that the patients returned to work in less than three weeks are in line with previous reports that have used flap techniques.^{5,10} The course of our pain, which is characterized by a reduction in VAS scores (ranging between 6.2 and 4.6 on postoperative day 1 and 7, respectively), indicates the generally positive pain profile of flap-based surgery. These results prove the idea that Limberg flap reconstruction is effective and well-tolerated during the initial recovery period.²⁰⁻²³ Kaplan-Meier survival analysis showed that a high probability of recurrence-free survival was observed in the 24 months period. The 18 months mark only registered one event (recurrence) and no further failures were observed after that. The plateau of the survival curve took place after that, implying long-term success in most of the patients. Although these results are positive, the event rate is low and cannot be interpreted statistically and must be considered with caution.

This cohort had a few complications that were minor. Two patients (4.1%), and one had to undergo advancement flap repair, experienced necrosis of the flap. There were also two patients with wound infection and partial dehiscence. Such results correspond to those of comparable series or are even better than those of complication, which implies that the procedure is not dangerous when conducted in standardized settings.⁶

The advantage of this research is that a high-risk population of patients will be involved. Over fifty percent of the patients were obese, more than three-quarters smokers, and a larger percentage of the patients had occupations which are known to be risk factors in poor surgical outcome- all these are indicators of obesity, smoking has been identified as a risk factor and occupations have been identified to be risk factors.^{24,25} In spite of these difficulties, most of the patients did not have

significant complications throughout the treatment, and most of them were very satisfied with their outcomes. Significantly, the research target population contained many participants of Fitzpatrick IV- VI skin types. The success of the diode laser in the group, which is traditionally the less represented group in the study of lasers, is in favor of its safe application in various types of skin, as observed by Pappas et al.¹⁹ as well.

Conclusion

Limberg flap reconstruction with adjuvant diode laser hair removal seems to be a safe and effective therapy on primary pilonidal sinus disease with low recurrence rates, acceptable rates of complication, and high levels of patient satisfaction after a 24 months follow-up. The dual-modality methodology can be specifically useful in the high-risk groups, such as obese populations, inactive jobs, and darker skins. In cases where possible, the diode laser therapy needs to be viewed as a normal adjunct of surgical excision in the treatment of PSD to improve the long-term outcomes.

Limitations of the Study: There are a number of limitations that need to be mentioned. To begin with, the single-center design and the lack of a control group do not allow the expansion of the results to other populations and prevent the direct comparison of the results with other interventions. Although the rate of recurrence and contentment rates are low and thus of help in laser therapy, it is impossible to conclude the same without randomized controlled trials.

Secondly, a low percentage of patients were lost to follow-up within the 24 months. Even though no signs of recurrence were present in any of these patients before they dropped out, there is no chance that the recurrence might be delayed. Thirdly, although laser compliance was closely followed, hair reduction evaluation by clinical judgment was used in all cases, not by standardized trichoscopic measure, due to logistical reasons.

Finally, the pain and satisfaction scores were based on self-reports of patients, which can cause recall bias or subjectivity. In spite of these limitations, the same results in a non-

homogenous and high-risk cohort provide important information regarding the possible use

of dual-modality therapy in the management of pilonidal disease.

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