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Original Research Article

PROSPECTIVE COMPARATIVE STUDY OF SINUS LASER CLOSURE (SILAC) VERSUS FLAP SURGERY FOR PILONIDAL SINUS DISEASE IN A TERTIARY CARE SETTING

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ABSTRACT

Background: Pilonidal sinus disease (PSD) is a chronic inflammatory condition associated with significant morbidity. While traditional flap procedures are established treatments, minimally invasive techniques like Sinus Laser Closure (SiLaC) have emerged to reduce recovery time and surgical trauma. This study aims to compare the clinical outcomes of SiLaC versus flap surgery in the management of PSD.

Materials and Methods: This prospective comparative study included 30 patients presenting with PSD at a tertiary care center. Patients were allocated to undergo either SiLaC (n=15) or flap surgery (Limberg or Karydakis; n=15) based on clinical suitability. Primary outcomes assessed were postoperative pain and wound healing. Secondary outcomes included hospital stay, return to work, complications, and early recurrence over a 6-month follow-up period.

Results: Both groups were comparable regarding baseline age, gender, and body mass index. SiLaC was associated with a significantly shorter mean operative time (25.1 ± 5.6 vs. 57.5 ± 11.3 minutes; p <0.0001) and hospital stay (3.06 ± 1.48 vs. 6.93 ± 1.94 days; p <0.0001) compared with flap surgery. Postoperative pain reduction within 3 days was reported by 93.33% of the SiLaC group versus 40.00% of the flap group (p =0.0008). Patients undergoing SiLaC returned to work earlier (2.9 ± 1.3 vs. 9.1 ± 2.6 days; p <0.0001). Differences in complete healing rates (86.67% vs. 53.33%; p =0.111), surgical site infections (6.67% vs. 26.67%; p =0.327), and short-term recurrence (0.00% vs. 26.67%; p =0.107) favoured SiLaC but did not reach statistical significance.

Conclusion: SiLaC is a safe and minimally invasive alternative to flap surgery for selected patients, associated with significantly reduced operative time, postoperative pain, and earlier return to normal activities. Flap surgery remains a viable option, though it is associated with longer recovery periods.

Keywords: Pilonidal sinus disease, Sinus Laser Closure, SiLaC, Flap surgery, Limberg flap, Karydakis flap, minimally invasive surgery.

INTRODUCTION

Pilonidal sinus disease (PSD) is an acquired chronic inflammatory condition primarily affecting the skin and subcutaneous tissues of the sacrococcygeal region, typically occurring in the natal cleft.[1] The pathogenesis is driven by the penetration of loose hair shafts into the skin, exacerbated by local friction, deep natal clefts, obesity, and sedentary lifestyles.[1,2] This condition predominantly affects young males during their most productive years, resulting in substantial physical discomfort and economic impact due to absenteeism and frequent recurrences.[3]

Surgical management of PSD has traditionally focused on wide excision of the sinus tracts,

followed by various closure methods. Off-midline flap techniques, such as the Limberg and Karydakis flaps, have been widely utilized to flatten the natal cleft, lateralize the surgical scar, and minimize recurrence.[4,5,6] Despite their efficacy, flap-based procedures require extensive tissue mobilization, longer operative times, and are frequently associated with delayed return to normal activities and postoperative complications such as surgical site infections and seroma formation.[7,8,9]

In recent years, the paradigm has shifted toward minimally invasive procedures that aim to preserve healthy tissue while ensuring adequate sinus obliteration. Sinus Laser Closure (SiLaC) utilizes radial-emitting diode laser energy to ablate the epithelial lining of the sinus tract, promoting closure by secondary fibrosis without the need for large excisions.[10,11,12]

Early evidence suggests that SiLaC may offer reduced postoperative morbidity and improved cosmetic outcomes, but prospective comparative data in specific regional demographics remain limited.[13,14]

Aim and Objectives: This prospective comparative study aimed to evaluate and compare the outcomes of SiLaC versus flap surgery in the management of PSD in a tertiary care setting. The primary objective was to assess postoperative pain and wound healing. Secondary objectives included the evaluation of operative time, hospital stay, and return to work, complication rates, and short-term recurrence.

MATERIALS AND METHODS

Study Design and Setting: This prospective comparative study was conducted over a 12-month period (comprising 6 months of recruitment and 6 months of follow-up) in the Department of General Surgery at M.G.M. Medical College and M.Y. Hospital, Indore.

Study Participants: The study included 30 patients aged 20 to 60 years diagnosed with PSD who provided informed consent. Patients were excluded if they presented with bleeding disorders, known immunodeficiency conditions, acute infection/abscesses, or concurrent anorectal pathologies (e.g., fistula-in-ano, haemorrhoids). Patients were assigned to either the SiLaC group (n=15) or the Flap method group (n=15) based on clinical decision and patient suitability, making this a non-randomized design.

Surgical Interventions

- **SiLaC Procedure:** The procedure was performed under local or spinal anaesthesia. Following thorough cleaning and curettage of the sinus tract to remove hair and debris, a radial-emitting diode laser fiber (1470 nm) was inserted into the tract. Laser energy (10-13 Watts) was delivered continuously while the fiber was withdrawn at a rate of approximately 1 mm/sec to induce photothermal coagulation of the epithelial lining. No surgical suturing was required.
- **Flap Method:** The flap procedure was performed under spinal or general anaesthesia in the prone jackknife position. The technique involved either a Limberg (rhomboid excision and transposition flap) or a Karydakis (asymmetric elliptical excision and fasciocutaneous flap) reconstruction. The choice of flap was based on the operating surgeon's preference. Subcutaneous drains were placed in the majority of flap surgeries to prevent seroma formation and were removed postoperatively depending on output.

Outcome Measures: Baseline demographics (age, gender, BMI) were recorded. Primary outcomes assessed were postoperative pain and wound healing duration. Secondary endpoints included operative duration, hospital stay, drain usage, postoperative complications (infection, seroma, hematoma), return to work, cosmetic results, and short-term recurrence at the 6-month follow-up. A cost comparison was also performed, evaluating surgical consumables, equipment, hospital stay, and indirect loss of work days.

Statistical Analysis: Data were recorded using a pre-designed pre-tested case proforma. Data entered in Microsoft excel and analysed using SPSS 25.0. Descriptive statistics were summarized as continuous and categorical variables. Comparative analyses between the two groups utilized the Chi-square test for categorical data and the t-test/Mann-Whitney U test for continuous variables. A p-value of <0.05 was considered statistically significant.

RESULTS

Table 1: Baseline Demographic and Clinical Characteristics

Characteristic	SiLaC Group (n = 15)	Flap Group (n = 15)	p-value
Age Group (years)	n (%)	n (%)	
< 25	2 (13.33%)	2 (13.33%)	1.000
26 - 35	10 (66.67%)	10 (66.67%)	
36 - 45	3 (20.00%)	3 (20.00%)	
Gender	n (%)	n (%)	
Male	12 (80.00%)	13 (86.67%)	1.000
Female	3 (20.00%)	2 (13.33%)	
Body Mass Index (BMI)	n (%)	n (%)	
18.5 - 25.0 (Normal)	5 (33.33%)	3 (20.00%)	0.307
25.1 - 30.0 (Overweight)	9 (60.00%)	8 (53.33%)	
> 30.0 (Obese)	1 (6.67%)	4 (26.67%)	

[Table 1] shows the distribution of age, gender, and Body Mass Index (BMI) across the Sinus Laser Closure (SiLaC) and Flap surgery groups. The majority of patients in both groups were aged 26-35 years (66.67%) and were male (80.00% in SiLaC, 86.67% in Flap). Overweight patients (BMI 25.1-30) comprised 60.00% of the SiLaC group and 53.33% of the Flap group, while obesity (BMI >30) was present in 6.67% and 26.67%, respectively. Statistical comparisons confirm no significant baseline differences (p >0.05) between the cohorts.

Table 2: Perioperative and Functional Recovery Outcomes

Parameter	SiLaC Group (n = 15)	Flap Group (n = 15)	p-value
Operative Details			
Duration of surgery (min), Mean ± SD	25.1 ± 5.6	57.5 ± 11.3	< 0.0001*
Operative time < 30 min, n (%)	12 (80.00%)	6 (40.00%)	0.425
Postoperative drain used, n (%)	0 (0.00%)	11 (73.33%)	0.0002*
Hospital Stay			
Duration of stay (days), Mean ± SD	3.06 ± 1.48	6.93 ± 1.94	< 0.0001*
Hospital stay < 3 days, n (%)	14 (93.33%)	6 (40.00%)	0.006*
Return to Normal Activity			
Time to return to work (days), Mean ± SD	2.9 ± 1.3	9.1 ± 2.6	< 0.0001*
Return to work ≤ 1 week, n (%)	14 (93.33%)	5 (33.33%)	0.002*

[Table 2] compares operative time, postoperative drain use, length of hospital stay, and time to return to work between the SiLaC and Flap groups. SiLaC was associated with a shorter mean operative time (25.1 ± 5.6 vs. 57.5 ± 11.3 minutes; p <0.0001), shorter hospital stay (3.06 ± 1.48 vs. 6.93 ± 1.94 days; p <0.0001), and earlier return to work (2.9 ± 1.3 vs. 9.1 ± 2.6 days; p <0.0001). No patients in the SiLaC group required postoperative drains, compared to 73.33% in the Flap group (p=0.0002).

Table 3: Postoperative Complications and Clinical Outcomes (6-Month Follow-Up)

Outcome	SiLaC Group (n = 15)	Flap Group (n = 15)	p-value
Wound Healing			
Complete wound healing, n (%)	13 (86.67%)	8 (53.33%)	0.111
Wound healing duration (days), Mean ± SD	30.8 ± 4.19	33.86 ± 4.53	0.032*
Postoperative Complications, n (%)			
Surgical site infection	1 (6.67%)	4 (26.67%)	0.327
Seroma	1 (6.67%)	3 (20.00%)	0.591
Hematoma	1 (6.67%)	2 (13.33%)	1.000
Early Recurrence (at 6 months)	0 (0.00%)	4 (26.67%)	0.107
Pain and Satisfaction, n (%)			
Reduced overall postoperative pain	14 (93.33%)	4 (26.67%)	0.0008*
Pain resolution within ≤ 3 days	14 (93.33%)	6 (40.00%)	-
Good cosmetic result	14 (93.33%)	9 (60.00%)	0.022*
High patient satisfaction	12 (80.00%)	9 (60.00%)	0.425

[Table 3] Outlines the incidence of complete wound healing, early recurrence, and surgical site complications alongside patient-reported outcomes at the 6-month follow-up. Complete wound healing occurred in 86.67% of SiLaC patients versus 53.33% of Flap patients (p =0.111). Postoperative pain reduction within 3 days was significantly higher in the SiLaC group (93.33%) compared to the Flap group (40.00%; p =0.0008). Good cosmetic outcomes favored SiLaC (93.33% vs. 60.00%; p =0.022), while early recurrence was 0.00% for SiLaC and 26.67% for Flap surgery (p =0.107). Surgical site infections were reported in 6.67% of SiLaC cases and 26.67% of Flap cases (p =0.327).

Table 4: Correlation between Preoperative Sinus Tract Length and Postoperative Discharge Duration

Sinus Tract Length	Mean Duration of Postoperative Discharge (Days)	Correlation Analysis
< 2 cm	5.5	Pearson's r: 0.58 p-value: 0.004*
2 - 4 cm	8.2	
> 4 cm	14.5	

[Table 4] Demonstrates the relationship between the measured length of the pilonidal sinus tract and the number of days patients experienced postoperative wound discharge. Patients with tracts <2 cm averaged 5.5 days. A moderate positive linear relationship was confirmed using Pearson's correlation (r =0.58, p =0.004).

Table 5: Estimated Cost Comparison between Surgical Modalities

Expenditure Category	SiLaC Group (INR)	Flap Group (INR)
Direct Costs		
Hospital Stay	2,100	5,500
Surgical Consumables	3,000	4,200

Laser Equipment & Fiber Cost	9,000	0
Medications & Dressings	2,200	3,000
Indirect Costs		
Income Loss (off-work days)	2,200	3,800
Total Estimated Cost	18,500	16,500

[Table 5] Summarizes the financial expenditure associated with each surgical modality in Indian Rupees (INR), excluding operating surgeon fees due to the public healthcare setting. SiLaC carried a higher total estimated cost of INR 18,500 compared to INR 16,500 for flap surgery. The SiLaC group incurred an additional INR 9,000 for laser equipment and fiber costs but demonstrated savings in hospital stay (INR 2,100 vs. INR 5,500) and reduced indirect income loss from off-work days (INR 2,200 vs. INR 3,800).

DISCUSSION

The surgical management of pilonidal sinus disease must balance the definitive excision of the pathology with the minimization of tissue trauma, pain, and patient downtime. The results of the present study indicate that SiLaC is a highly efficient, minimally invasive alternative that significantly improves early postoperative parameters compared to traditional flap reconstructions.

SiLaC was associated with a markedly shorter operative time (25.1 minutes vs. 57.5 minutes) and hospital stay. This is consistent with findings by **Sluckin TC et al.**[12] and **Pappas AF et al,**[10] who highlighted the procedural efficiency of diode laser ablation due to the absence of wide tissue excision and suturing. Furthermore, avoiding large tissue defects eliminated the need for postoperative surgical drains in the SiLaC group, simplifying postoperative care.

A primary advantage of SiLaC demonstrated in this cohort was the substantial reduction in early postoperative pain. Over 93% of SiLaC patients experienced pain resolution within three days, leading directly to an accelerated return to work (mean 2.9 days). In contrast, flap surgery patients required an average of 9.1 days to resume professional activities. This rapid functional recovery echoes the results of **Horesh N et al,**[13] and **Georgiou GK et al,**[14] who established that minimal disruption of the natal cleft anatomy facilitates earlier mobility and limits indirect economic losses.

Wound complication rates, including infection (6.67% vs. 26.67%) and seroma (6.67% vs. 20.00%), demonstrated a trend favoring SiLaC, though statistical significance was not reached, likely due to the limited sample size. Flap surgeries, such as the Limberg and Karydakis procedures, involve extensive subcutaneous mobilization that predisposes the patient to dead space formation and fluid collection.[4,5,9]

The study found no short-term recurrences in the SiLaC group over the 6-month follow-up, compared to a 26.67% recurrence rate in the flap cohort. While flap procedures generally boast long-term recurrence rates under 10% in high-volume specialized centers,[5,8] the higher early recurrence observed in the flap arm of the present study may relate to the higher BMI profile (26.67% obesity) and associated wound tension. Although SiLaC utilizes thermal ablation rather than physical excision, systematic reviews by **Iesalnieks I et al,**[3] and **Milone M et al,**[15] note that meticulous laser energy delivery to properly debrided tracts can result in durable healing.

Furthermore, the linear correlation between sinus tract length and the duration of postoperative discharge highlights the importance of patient selection. For patients with tracts exceeding 4 cm, surgeons should anticipate prolonged discharge, necessitating proper preoperative counseling regarding expected wound care.

Strengths and Limitations

The prospective nature of this study allows for structured outcome tracking in a real-world clinical setting. However, several limitations must be acknowledged. The sample size of 30 patients is small, restricting the statistical power to detect definitive differences in secondary endpoints such as complications and recurrence. The non-randomized design introduces inherent selection bias, as treatment allocation was based on clinical judgment. Additionally, the "Flap method" group was heterogeneous, encompassing both Limberg and Karydakis techniques, which carry slightly different morbidity profiles. Finally, the 6-month follow-up period is insufficient to draw robust conclusions regarding the long-term recurrence rates of PSD, necessitating cautious interpretation of the efficacy data.

CONCLUSION

Sinus Laser Closure (SiLaC) is a safe, time-efficient, and minimally invasive technique that offers distinct advantages over conventional flap surgery for the management of pilonidal sinus disease. SiLaC is associated with significantly reduced operative time, lower postoperative pain, and an earlier return to professional activities. While flap surgery remains an effective intervention for complex or extensive disease, SiLaC represents a highly satisfactory primary option for selected patients that mitigates the functional and aesthetic burdens of traditional excisional surgery.

Declarations Ethics Approval: Prior approval was obtained from the Institutional Ethics Committee of

M.G.M. Medical College, Indore. Written informed consent was obtained from all participants prior to inclusion in the study.

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