International Surgery Journal
*Singh A et al. Int Surg J. 2026 Oct;13(10):xxx-xxx*
https://www.ijsurgery.com
pISSN 2349-3305 | eISSN 2349-2902

DOI: https://dx.doi.org/10.18203/2349-2902.isj20263285

**Original Research Article**

# Beyond the scalpel: post-operative outcomes of radial diode laser ablation in sacrococcygeal pilonidal sinus disease

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**Received:** 31 August 2026
**Revised:** 07 September 2026
**Accepted:** 11 September 2026

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## ABSTRACT

**Background:** Conventional excisional surgery for sacrococcygeal pilonidal sinus disease repays cure with weeks of open wound care. This study evaluated post-operative outcomes of 1470-nm radial diode laser ablation and the factors governing healing.
**Methods:** Fifty consecutive patients underwent curettage and 1470-nm radial diode laser ablation at 10 W in a prospective observational study in Kanpur, India, between October 2024 and February 2026. Age, sex, body mass index, family history, morphological stage, occupational sitting duration, gluteal hair density and hair shaft thickness were tested against healing time, delayed healing beyond 30 days and six-month recurrence, univariably and by multivariable linear regression.
**Results:** Mean age was 25.0±5.3 years and 42 patients (84.0%) were men. Mean operating time was 26.1±8.7 minutes, hospital stay 1.3±0.5 days and day-7 pain 1.2±0.8. Mean healing time was 28.5±10.2 days; 46 patients (92.0%) had no complication and three (6.0%) recurred. Healing time rose with stage (20.1 to 43.5 days; $F=22.19$, $p<0.001$), sitting duration ($F=5.37$, $p=0.008$), body mass index ($r=0.344$, $p=0.014$) and hair density ($F=3.61$, $p=0.035$). Delayed healing was associated with advanced stage (76.5% versus 3.0%), overweight (77.8% versus 17.1%), sitting beyond six hours daily (54.5% versus 7.1%) and dense gluteal hair (53.3% versus 17.1%; all $p\leq0.016$). Hair shaft thickness predicted nothing. On multivariable regression only stage remained independent ($B=5.60$ days per stage, $p<0.001$; $R^2=0.737$). No factor predicted recurrence.
**Conclusions:** Laser ablation achieved day-care surgery with minimal pain and 6.0% recurrence. Morphological stage governed healing; body mass index, sedentary work and hair density acted through it.

**Keywords:** Body mass index, Diode laser, Hair density, Pilonidal sinus, Sedentary occupation, Wound healing

## INTRODUCTION

Sacrococcygeal pilonidal sinus disease is a chronic inflammatory condition of the natal cleft characterised by one or more midline pits communicating with a granulation-lined tract that harbour loose hair and debris. The name captures the pathology precisely: pilus, hair, and nidus, nest. Repeated episodes of pain, discharge and abscess formation punctuate the natural history, and the condition preferentially strikes men in the second and third decades of life, precisely the population least able to absorb prolonged convalescence.[1] The reported incidence has risen over recent decades, an increase generally attributed to sedentary work patterns, prolonged sitting, obesity, abundant coarse body hair, a deep natal cleft and inadequate local hygiene.[2] Although never life-threatening, the morbidity is cumulative: recurrent suppuration, delayed healing and repeated operations

exact a disproportionate toll on productivity and quality of life. Conventional management has centred on wide excision with healing by secondary intention, excision with primary closure, or flap procedures such as the Limberg and Karydakis repairs. These achieve durable clearance but at a cost: substantial pain, hospital stay measured in days, healing measured in weeks, infection, dehiscence, poor cosmesis and recurrence rates spanning 5% to 30%.[3,4] No excisional technique has been accepted as a gold standard.

Dissatisfaction with this trade-off has driven minimally invasive alternatives that treat the tract rather than resect the surrounding tissue. Endoscopic pilonidal sinus treatment and video-assisted ablation established that sinus destruction under direct vision could achieve healing with markedly less tissue loss.[5,6] Laser ablation extends this principle: a radial-emitting fibre is advanced to the base of the curetted tract and withdrawn slowly, delivering circumferential thermal energy that destroys the epithelial lining and collapses the tract. Early series reported healing rates approaching 90% with minimal wounds and low recurrence, and systematic reviews have concluded that laser techniques consistently produce lower morbidity than excisional surgery.[7-10]

Two questions remain incompletely answered. First, whether outcomes described in specialised European series are reproducible in a high-volume government teaching hospital, since prospective Indian data are sparse. Second, which patient and disease characteristics govern how quickly a laser-treated sinus heals. Body mass index, hair burden, disease complexity and sedentary work are all cited as risk factors for the disease itself, yet their influence on outcome after ablation has rarely been quantified in one study. This study therefore evaluated post-operative outcomes of 1470-nm radial diode laser ablation and tested eight patient and disease factors as determinants of healing and recurrence.

## METHODS

### *Study design and setting*

This institution-based prospective observational study was conducted in the Department of General Surgery, GSVM Medical College and LLR Hospital, Kanpur, Uttar Pradesh, India, between October 2024 and February 2026. Fifty consecutive patients presenting to the surgical outpatient department or admitted with sacrococcygeal pilonidal sinus disease, who met the eligibility criteria and consented to laser ablation, were enrolled. The study was reported in accordance with the STROBE recommendations for observational research.

### *Participants and baseline assessment*

Patients aged 12 to 60 years with chronic or recurrent pilonidal sinus disease were eligible. Patients with an acute pilonidal abscess, those receiving cancer chemotherapy, immunocompromised patients, those unable to cooperate with follow-up or with psychiatric illness, and those unwilling to undergo surgery were excluded.

All patients underwent clinical assessment supplemented, where indicated, by sinus probing, sinography, ultrasonography, computed tomography or magnetic resonance imaging to define tract anatomy and to exclude presacral pathology, fistula-in-ano and hidradenitis suppurativa. Height and weight were recorded and body mass index calculated as weight in kilograms divided by the square of height in metres, categorised as normal (<25 kg/m²), overweight (25-30 kg/m²) or obese (>30 kg/m²). A family history of pilonidal disease was recorded when reported in a first-degree relative. Disease was staged using the morphological classification for sacrococcygeal pilonidal disease: stage I, single midline pit; stage IIa, two to three midline pits; stage IIb, more than three midline pits; stage III, midline pits with unilateral lateral extension; and stage IV, midline pits with bilateral lateral extension.8 Occupation over the preceding two years was taken as the patient's profession, and hours spent seated during a usual working day were categorised as low (<4 hours/day), moderate (4-6 hours/day) or high (>6 hours/day).

Gluteal hair density was graded by asking the patient to shave the natal cleft region and counting regrowth 48 to 72 hours later within a band extending 2 cm on either side of the intergluteal sulcus, as sparse (<10 hairs/cm²), moderate (10-40 hairs/cm²) or dense (>40 hairs/cm²). Hair shaft thickness was assessed by microscopic comparison of plucked gluteal hairs against a 6-0 nylon suture of known 60-80 µm diameter, and graded as thin (<60 µm), medium (60-80 µm) or thick (>80 µm). Both gradings were performed pre-operatively by the operating team.

### *Operative technique*

All procedures were performed by the same surgical unit under local, spinal or general anaesthesia. The patient was positioned prone with the buttocks retracted, and the shaved field prepared with antiseptic solution. Primary pits and secondary openings were identified, the tract was delineated with a probe and methylene blue dye, and the primary pit was enlarged by a small incision or punch excision, with the excised margin sent for histopathology.

The tract was curetted to remove hair, debris and granulation tissue and irrigated with normal saline. A radial-emitting 1470-nm diode laser fibre was introduced along the tract to its deepest point. Energy was delivered at 10 W while the fibre was withdrawn continuously at approximately 1 mm/s, producing thermal destruction of the sinus epithelium, collapse of the tract and coagulation of small vessels (Figure 1). The tract was re-curetted to evacuate carbonized debris, ablation was repeated to eliminate residual epithelial lining, and a final saline

lavage performed. The pit was left open for drainage and covered with a sterile dressing; no wide excision or primary suture was undertaken.

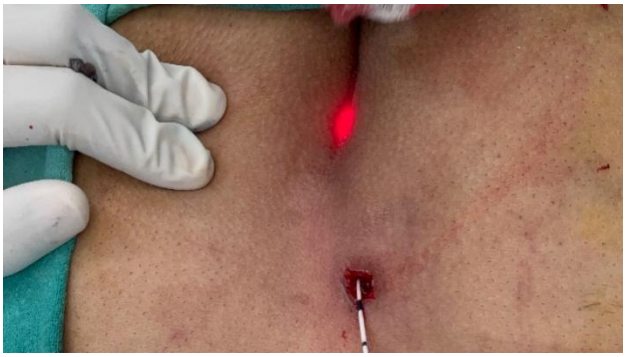

**Figure 1: Intraoperative photograph showing ablation of the sinus tract with the radial-emitting 1470-nm diode laser fibre, delivered at 10 W with continuous withdrawal of the fibre at approximately 1 mm/s.**

### *Post-operative care and follow-up*

Patients were discharged the same day or within 24 hours once ambulant and comfortable on oral analgesia. Topical antibiotic, analgesics and instructions on dressing, local hygiene, natal cleft hair removal and avoidance of prolonged sitting were given at discharge. Patients were reviewed weekly for the first month and monthly until six months, with clinical examination for wound status, pain, infection and recurrence at each visit.

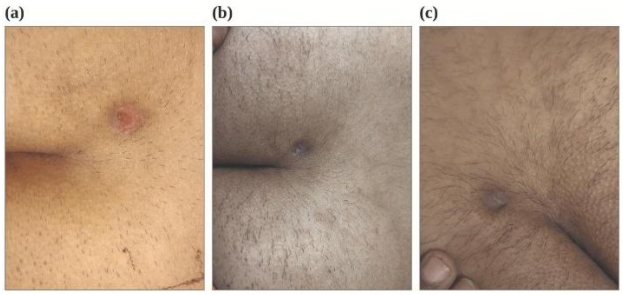


**Figure 2 (a-c): Sequential wound status after laser ablation. Post-operative week 1, showing a small open pit with minimal surrounding inflammation. Post-operative week 2, showing contraction of the wound with healthy granulation. Post-operative week 3, showing near-complete epithelialisation.**

### *Outcome definitions*

Operating time was the interval from skin incision to completion of dressing, and duration of hospital stay was counted in days from operation to discharge. Post-operative pain was assessed on day 7 using a four-point verbal rating scale (0, no pain; 1, mild; 2, moderate; 3, severe). Healing time was the interval in days from surgery to complete epithelialization without discharge or signs of infection, and delayed healing was defined as failure to heal within 30 days. Recurrence was defined as reappearance of a sinus opening, discharge or abscess in the previously treated area after complete healing, recorded on clinical examination during the six-month follow-up period (Figure 2).

### *Statistical analysis*

Data were analysed using SPSS version 25.0 (IBM Corp., Armonk, NY, USA). Continuous variables are presented as mean±standard deviation with median and range, and categorical variables as frequencies and percentages. Eight candidate predictors were examined against outcome: age, sex, body mass index, family history, morphological disease stage, occupational sitting duration, gluteal hair density and hair shaft thickness.

Continuous predictors were related to healing time by Pearson correlation with Spearman rank correlation as a non-parametric check. Healing time was compared across two-level predictors by Welch's t test with the Mann-Whitney U test as confirmation, and across multi-level predictors by one-way analysis of variance with the Kruskal-Wallis H test as confirmation.

Associations with the binary outcomes of delayed healing and six-month recurrence were tested by the Pearson chi-square test, with Fisher's exact test applied to all 2×2 comparisons and wherever expected cell frequencies fell below five. For the binary outcomes, four predictors were additionally collapsed, each specified before analysis, in order to preserve adequate cell counts: disease stage into early (I-IIa) and advanced (IIb-IV); sitting duration into ≤6 and >6 hours/day; hair density into dense versus sparse or moderate; and hair shaft thickness into thick versus thin or medium.

Independent predictors of healing time were sought by multivariable linear regression entering all eight candidate predictors simultaneously, with disease stage, sitting duration, hair density and hair shaft thickness modelled as ordinal terms and multicollinearity assessed by the variance inflation factor. Multivariable logistic modelling of delayed healing and of recurrence was not attempted, because 14 and 3 events respectively provided too few events per variable for stable estimation. A two-sided p value below 0.05 was considered significant and a value below 0.01 highly significant.

### *Ethical considerations*

The study protocol was approved by the Institutional Ethics Committee of GSVM Medical College, Kanpur (approval number EC/BMHR/2024/165). Written informed consent for the procedure and for study participation was obtained from every participant in the vernacular language (Hindi) before enrolment; for the two participants below 18 years of age, consent was obtained from a parent or legal guardian together with the assent of the participant. Patient identity was anonymized

using sequential study identification numbers and the study was conducted in accordance with the Declaration of Helsinki.

## RESULTS

### *Baseline characteristics*

Fifty patients underwent 1470-nm radial diode laser ablation and all completed six months of follow-up, with no loss to follow-up. The mean age was 25.0±5.3 years (median 24, range 15-37 years) and 48 patients (96.0%) were aged 18 to 40 years. Men predominated strongly, comprising 42 patients (84.0%) against 8 women (16.0%). Mean body mass index was 23.0±2.1 kg/m² (range 19.0-28.0 kg/m²); 41 patients (82.0%) were of normal weight and 9 (18.0%) overweight, and no patient was obese. A positive family history was elicited in 3 patients (6.0%). Early-stage disease predominated, stage I and IIa together accounting for 33 patients (66.0%). Sedentary work was common, 22 patients (44.0%) being seated for more than six hours each working day, and gluteal hair was dense in 15 patients (30.0%) and of thick shaft calibre in 15 (30.0%) (Table 1).

### *Operative and post-operative outcomes*

The mean operating time was 26.1±8.7 minutes (median 23.5, range 15-45 minutes) and the mean hospital stay 1.3±0.5 days (median 1.0, range 1-3 days), the majority of patients being discharged within 24 hours. The mean pain score on day 7 was 1.2±0.8 on the four-point scale (median 1.0, range 0-3), corresponding to absent or mild pain in most patients. Complete wound healing was achieved at a mean of 28.5±10.2 days (median 25.5, range 15-57 days) (Table 2).

**Table 1: Baseline demographic and clinical characteristics of the study population (n=50).**

| Variable | Category/statistic | Value | %/range |
|---|---|---|---|
| **Age (in years)** | Mean±SD | 25.0±5.3 | 15-37 |
| | Median | 24 | - |
| | 18-40 | 48 | 96.0 |
| **Sex** | Male | 42 | 84.0 |
| | Female | 8 | 16.0 |
| **Body mass index (kg/m²)** | Mean±SD | 23.0±2.1 | 19.0-28.0 |
| | Normal (<25) | 41 | 82.0 |
| | Overweight (25-30) | 9 | 18.0 |
| | Obese (>30) | 0 | 0.0 |
| **Family history** | Present | 3 | 6.0 |
| | Absent | 47 | 94.0 |
| **Morphological stage** | I | 17 | 34.0 |
| | IIa | 16 | 32.0 |
| | IIb | 5 | 10.0 |
| | III | 10 | 20.0 |
| | IV | 2 | 4.0 |
| **Occupational sitting duration** | <4 hours/day | 12 | 24.0 |
| | 4-6 hours/day | 16 | 32.0 |
| | >6 hours/day | 22 | 44.0 |
| **Gluteal hair density** | Sparse (<10/cm²) | 13 | 26.0 |
| | Moderate (10-40/cm²) | 22 | 44.0 |
| | Dense (>40/cm²) | 15 | 30.0 |
| **Hair shaft thickness** | Thin (<60 µm) | 15 | 30.0 |
| | Medium (60-80 µm) | 20 | 40.0 |
| | Thick (>80 µm) | 15 | 30.0 |

**Table 2: Operative outcomes, complications and wound healing status (n=50).**

| Parameter | Mean±SD or N (%) | Median | Range |
|---|---|---|---|
| **Operative and post-operative measures** | | | |
| Operating time (minutes) | 26.1±8.7 | 23.5 | 15-45 |
| Duration of hospital stay (days) | 1.3±0.5 | 1.0 | 1-3 |
| Pain score on day 7 (0-3 scale) | 1.2±0.8 | 1.0 | 0-3 |
| Healing time (days) | 28.5±10.2 | 25.5 | 15-57 |
| **Complications** | | | |
| None | 46 (92.0) | - | - |

Continued.

| Parameter | Mean±SD or N (%) | Median | Range |
|---|---|---|---|
| Recurrence at six months | 3 (6.0) | - | - |
| Mild wound infection | 1 (2.0) | - | - |
| Serious complication | 0 (0.0) | - | - |
| **Wound healing status at 30 days** | | | |
| Normal healing (≤30 days) | 36 (72.0) | - | - |
| Delayed healing (>30 days) | 14 (28.0) | - | - |

Forty-six patients (92.0%) completed follow-up without any complication. Mild wound infection occurred in one patient (2.0%) and settled with oral antibiotics and dressings alone, and recurrence was documented in three (6.0%), each managed by repeat laser ablation. The overall complication rate was 8.0%, with no haemorrhage, deep-space infection, urinary retention or anaesthetic adverse event, giving a serious complication rate of 0%. Thirty-six patients (72.0%) healed within 30 days at a mean of 23.7 days, while 14 (28.0%) met the definition of delayed healing at a mean of 40.8 days (Table 2).

***Predictors of healing time***

Morphological stage was by far the most powerful correlate of healing time. Mean healing rose steadily from 20.1±2.9 days in stage I to 26.6±2.7 days in stage IIa, 31.8±5.8 days in stage IIb, 41.1±12.1 days in stage III and 43.5±3.5 days in stage IV ($F=22.191$, $p<0.001$; Kruskal-Wallis $H=34.670$, $p<0.001$) (Table 3, Figure 3A).

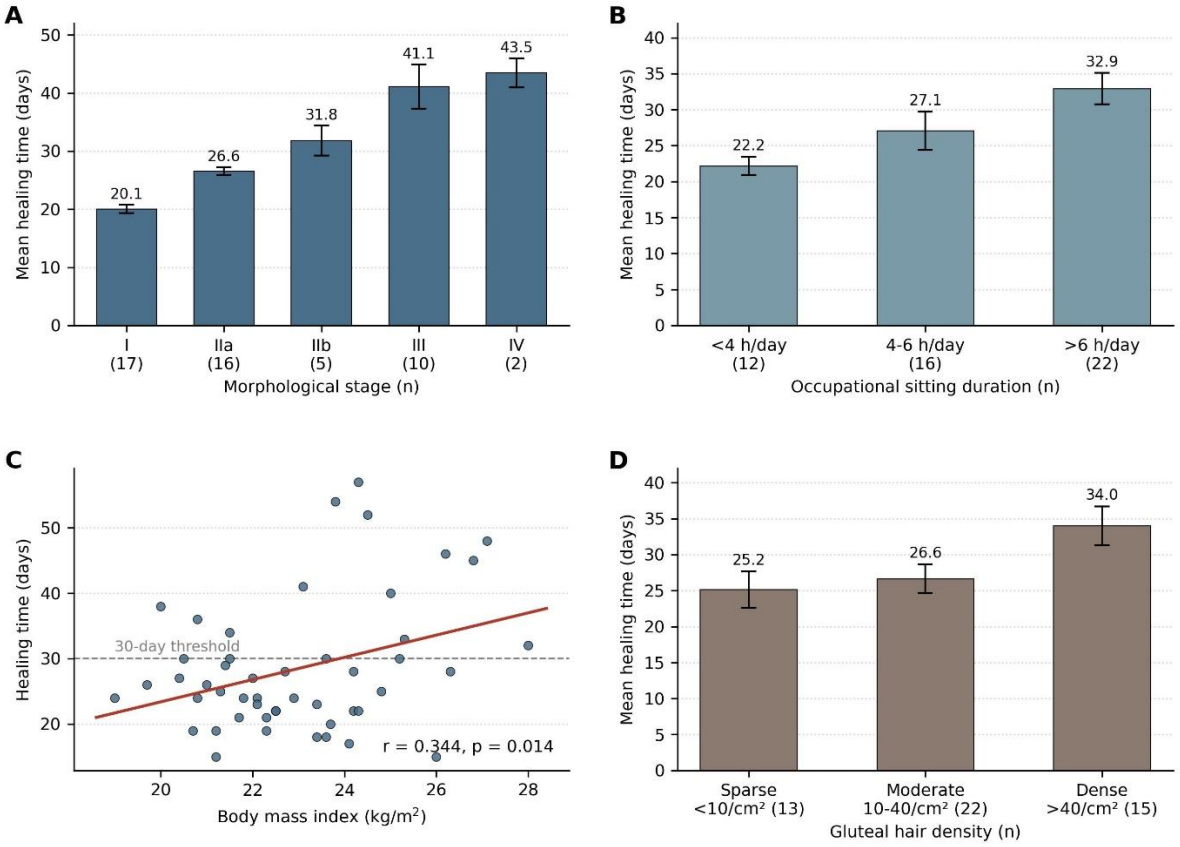


**Figure 3: Determinants of healing time after laser ablation. Bars show the mean with error bars representing the standard error of the mean, and group sizes are given in parentheses. (A) Morphological stage: healing time more than doubled from stage I to stage IV ($F=22.19$, $p<0.001$; $H=34.67$, $p<0.001$). (B) Occupational sitting duration: patients seated for more than six hours daily healed 10.7 days later on average than those seated for less than four hours ($F=5.37$, $p=0.008$; $H=12.30$, $p=0.002$). (C) Body mass index against healing time with fitted least-squares regression line, the dashed line marking the 30-day threshold defining delayed healing (Pearson $r=0.344$, $p=0.014$). (D) Gluteal hair density: patients with dense hair healed 8.8 days later on average than those with sparse hair ($F=3.61$, $p=0.035$; $H=7.77$, $p=0.021$). F: one-way ANOVA; H: Kruskal-Wallis H test.**

**Table 3: Univariable analysis of predictors of healing time (n=50).**

| Predictor and category | N | Healing time, mean±SD (days) | Parametric test (p) | Non-parametric test (p) |
|---|---|---|---|---|
| **Sex: male** | 42 | 29.5±10.7 | t=3.16 (0.003) | U=232.0 (0.092) |
| **Sex: female** | 8 | 23.0±3.5 | | |
| **BMI: normal (<25)** | 41 | 27.0±9.6 | t=2.15 (0.055) | U=88.0 (0.015) |
| **BMI: overweight (25-30)** | 9 | 35.2±10.6 | | |
| **Family history: absent** | 47 | 27.9±9.6 | t=1.05 (0.399) | U=33.0 (0.130) |
| **Family history: present** | 3 | 38.0±16.5 | | |
| **Stage I** | 17 | 20.1±2.9 | F=22.19 (<0.001) | H=34.67 (<0.001) |
| **Stage IIa** | 16 | 26.6±2.7 | | |
| **Stage IIb** | 5 | 31.8±5.8 | | |
| **Stage III** | 10 | 41.1±12.1 | | |
| **Stage IV** | 2 | 43.5±3.5 | | |
| **Sitting: <4 hours/day** | 12 | 22.2±4.4 | F=5.37 (0.008) | H=12.30 (0.002) |
| **Sitting: 4-6 hours/day** | 16 | 27.1±10.7 | | |
| **Sitting: >6 hours/day** | 22 | 32.9±10.2 | | |
| **Hair density: sparse** | 13 | 25.2±9.1 | F=3.61 (0.035) | H=7.77 (0.021) |
| **Hair density: moderate** | 22 | 26.6±9.4 | | |
| **Hair density: dense** | 15 | 34.0±10.5 | | |
| **Hair shaft: thin** | 15 | 24.8±5.1 | F=3.07 (0.056) | H=2.23 (0.328) |
| **Hair shaft: medium** | 20 | 27.5±8.7 | | |
| **Hair shaft: thick** | 15 | 33.4±13.8 | | |

Occupational sitting duration showed a clear dose-response pattern, with mean healing of 22.2±4.4, 27.1±10.7 and 32.9±10.2 days across the <4, 4-6 and >6 hours strata (F=5.365, p=0.008; H=12.302, p=0.002) (Figure 3B). Body mass index correlated positively with healing time as a continuous variable (Pearson r=0.344, p=0.014; Spearman ρ=0.238, p=0.097) (Figure 3C); overweight patients healed in 35.2±10.6 days against 27.0±9.6 days, a difference significant on non-parametric testing (Mann-Whitney p=0.015) though borderline on Welch's t test (p=0.055). Men healed more slowly than women (29.5±10.7 versus 23.0±3.5 days, t=3.161, p=0.003), though rank-based testing did not confirm this (p=0.092), reflecting the far greater variance among men. Neither age (r=0.101, p=0.487) nor family history (p=0.399) was significantly associated with healing time.

Gluteal hair density showed a comparable gradient: mean healing was 25.2±9.1 days with sparse hair, 26.6±9.4 days with moderate hair and 34.0±10.5 days with dense hair, significant on both parametric and rank-based testing (F=3.614, p=0.035; H=7.770, p=0.021) (Figure 3D). Hair shaft thickness produced a weaker and less consistent signal, mean healing being 24.8±5.1, 27.5±8.7 and 33.4±13.8 days for thin, medium and thick shafts; this reached neither parametric nor rank-based significance (F=3.069, p=0.056; H=2.229, p=0.328), the wide dispersion in the thick-shaft group accounting for the discrepancy (Table 3).

***Predictors of delayed healing***

Delayed healing beyond 30 days occurred in 13 of 17 patients with advanced-stage disease (76.5%) against 1 of 33 with early-stage disease (3.0%) (Fisher's exact p<0.001), in 7 of 9 overweight patients (77.8%) against 7 of 41 normal-weight patients (17.1%) (p=0.001, odds ratio 17.0), in 12 of 22 patients seated more than six hours daily (54.5%) against 2 of 28 seated for six hours or less (7.1%) (p<0.001), and in 8 of 15 patients with dense gluteal hair (53.3%) against 6 of 35 with sparse or moderate hair (17.1%) (p=0.016, odds ratio 5.5). Mean body mass index was 24.5±2.4 kg/m² in patients with delayed healing against 22.4±1.6 kg/m² in those healing normally (p=0.009). Thick hair shafts conferred no significant excess (40.0% versus 22.9%, p=0.304), sex showed a non-significant trend (33.3% of men and no woman, p=0.087), and family history showed no association (p=1.000) (Table 4).

***Predictors of recurrence***

None of the eight predictors was significantly associated with recurrence at six months: sex (p=1.000), body mass index category (p=1.000), family history (p=0.173), disease stage (p=1.000 collapsed; $\chi^2$=3.014, p=0.555 across five strata), sitting duration (p=1.000 collapsed; $\chi^2$=2.047, p=0.359 across three strata), hair density (p=0.211 collapsed; $\chi^2$=2.343, p=0.310) or hair shaft thickness (p=1.000 collapsed; $\chi^2$=1.537, p=0.464). With only three events every one of these analyses was severely underpowered (Table 4).

***Independent predictors of healing time***

The multivariable linear model containing all eight predictors explained 73.7% of the variance in healing time (adjusted $R^2$=0.686; F (8,41) =14.367, p<0.001),

with all variance inflation factors below 2.1. Disease stage was the only independent predictor, each step up the morphological classification adding 5.60 days to healing (95% confidence interval 4.07 to 7.14, p<0.001). Every other candidate was attenuated to non-significance once stage was accounted for: family history (p=0.084), sitting duration (p=0.061), body mass index (p=0.238), hair shaft thickness (p=0.251) and hair density (p=0.861), while age and sex contributed nothing (Table 5).

**Table 4: Predictors of delayed healing beyond 30 days and of recurrence at six months (n=50).**

| Predictor and category | N | Delayed healing, N (%) | P value | Recurrence, N (%) | P value |
|---|---|---|---|---|---|
| **Sex: male** | 42 | 14 (33.3) | 0.087 | 3 (7.1) | 1.000 |
| **Sex: female** | 8 | 0 (0.0) | | 0 (0.0) | |
| **BMI: normal (<25)** | 41 | 7 (17.1) | 0.001 | 3 (7.3) | 1.000 |
| **BMI: overweight (25-30)** | 9 | 7 (77.8) | | 0 (0.0) | |
| **Family history: absent** | 47 | 13 (27.7) | 1.000 | 2 (4.3) | 0.173 |
| **Family history: present** | 3 | 1 (33.3) | | 1 (33.3) | |
| **Stage: early (I-IIa)** | 33 | 1 (3.0) | <0.001 | 2 (6.1) | 1.000 |
| **Stage: advanced (IIb-IV)** | 17 | 13 (76.5) | | 1 (5.9) | |
| **Sitting: ≤6 hours/day** | 28 | 2 (7.1) | <0.001 | 2 (7.1) | 1.000 |
| **Sitting: >6 hours/day** | 22 | 12 (54.5) | | 1 (4.5) | |
| **Hair density: sparse or moderate** | 35 | 6 (17.1) | 0.016 | 1 (2.9) | 0.211 |
| **Hair density: dense** | 15 | 8 (53.3) | | 2 (13.3) | |
| **Hair shaft: thin or medium** | 35 | 8 (22.9) | 0.304 | 2 (5.7) | 1.000 |
| **Hair shaft: thick** | 15 | 6 (40.0) | | 1 (6.7) | |

**Table 5: Multivariable linear regression model for healing time (n=50).**

| Predictor | B (days) | SE | 95% CI | t | P value |
|---|---|---|---|---|---|
| **Age (per year)** | 0.000 | 0.209 | -0.422 to 0.423 | 0.00 | 0.998 |
| **Male sex** | -1.182 | 2.657 | -6.549 to 4.185 | -0.44 | 0.659 |
| **Body mass index (per kg/m²)** | 0.672 | 0.561 | -0.462 to 1.806 | 1.20 | 0.238 |
| **Family history present** | 6.413 | 3.616 | -0.889 to 13.714 | 1.77 | 0.084 |
| **Disease stage (per stage)** | 5.604 | 0.759 | 4.071 to 7.137 | 7.38 | <0.001 |
| **Sitting duration (per category)** | 2.232 | 1.159 | -0.109 to 4.573 | 1.93 | 0.061 |
| **Hair density (per grade)** | -0.215 | 1.220 | -2.679 to 2.249 | -0.18 | 0.861 |
| **Hair shaft thickness (per grade)** | 1.474 | 1.265 | -1.081 to 4.028 | 1.17 | 0.251 |

## DISCUSSION

This prospective series of 50 patients treated by 1470-nm radial diode laser ablation reproduces, in an Indian government teaching hospital, the favourable post-operative profile reported from specialised European centres, and shows that the pace of healing after ablation is governed chiefly by the morphological complexity of the sinus itself.

### *Demographic profile and post-operative outcomes*

The mean age of 25.0±5.3 years, with 96.0% aged 18 to 40, matches the established epidemiology: de Parades et al described the disease as affecting patients aged 15 to 35 years, and Pappas et al reported a median age of 24 years.[1,7] The male predominance here (84.0%) exceeds the 3-4:1 ratio typical of published series, plausibly reflecting healthcare-access patterns in North India.[3] The overall complication rate of 8.0%, comprising three recurrences and a single mild wound infection, compares favorably with published experience. Pappas et al recorded wound infection in 7.2% of patients and Dessily et al an overall complication rate of 15%.[7,8] Van Hoof et al likewise found serious complications rare, and Romic et al concluded that laser techniques carry lower morbidity than excisional surgery, which has complication rates of 20-40%.[4,9,11] The absence of any serious complication here supports day-care delivery. The mean operating time of 26.1 minutes and hospital stay of 1.3 days are consistent with Pappas et al and the brief admission mirrors the day-care model advanced for endoscopic treatment.[5,7,8] The mean day-7 pain score of 1.2±0.8 corresponds to absent or mild pain in most patients. Because a four-point scale was used, direct comparison with 0-10 visual analogue scale series is inappropriate, but the finding is qualitatively concordant with Sahsamanis et al and with the randomised comparison by Pronk et al in which phenolisation produced significantly less pain than radical excision.[12,13] Complete healing at a mean of 28.5±10.2 days sits within the favourable range of the laser literature: Meinero et al reported 26.7 days and Dessily et al 19.5 days, whereas Pappas et al recorded a longer median of 47 days.[5,7,8] Li et al, Harju et al and Bonito et al have all reported high healing rates with the radial diode fibre.[14-16]

***Morphological stage is the dominant determinant of healing***

The central finding is the magnitude and consistency of the stage effect. Healing time more than doubled from stage I to stage IV, the association was highly significant on both parametric and rank-based testing, and stage alone carried most of the explanatory power of the eight-variable model, adding 5.6 days per step after adjustment for every other candidate. Delayed healing was almost confined to advanced disease, occurring in 76.5% of stage IIb-IV patients against 3.0% of stage I-IIa patients. Dessily et al similarly identified secondary openings and tract complexity as the principal factors influencing healing after sinus laser closure.8 The practical implication is immediate: the most effective way to shorten convalescence after laser ablation is to operate before lateral extensions develop, which makes the case for early referral of patients presenting with a simple midline pit rather than a period of watchful waiting.

***Body mass index, sedentary occupation and hair burden***

Three further factors were strongly associated with slower healing on univariable analysis and none survived adjustment for stage, a pattern that is itself informative. Overweight patients were seventeen times more likely to experience delayed healing than normal-weight patients. Obesity is a recognised determinant of wound complications after conventional pilonidal surgery, mediated through impaired local vascularity and a deeper intergluteal cleft, and Yardimci reported body mass index as a confounder in multivariate analysis of laser outcomes.[2,17] The narrow range of body mass index here, entirely below 30 kg/m², limits the power to detect an independent effect, and the finding should not be read as reassurance that obesity is irrelevant after ablation.

Occupational sitting duration told the same story, with a stepwise gradient across the three strata and delayed healing almost eight times more frequent among those seated beyond six hours daily. Sustained pressure over the natal cleft compresses the dermal microvasculature, reduces oxygen delivery and generates repetitive shear at the healing interface. Vartanian et al identified sustained perianal pressure as a contributor to poor healing irrespective of technique, and the Italian society of colorectal surgery guidelines explicitly recommend avoidance of prolonged sitting after pilonidal surgery.[2,3] Because the advice is free and risk-free, structured occupational counselling remains worth giving: a coccyx-relief cushion, hourly standing breaks, and temporary redeployment to non-sedentary duties for four to six weeks.

Gluteal hair density behaved identically. Dense hair was associated with nine days of additional healing and a threefold excess of delayed healing, yet contributed nothing once stage entered the model. The explanation is visible in the data: hair density correlated with morphological stage (Spearman $\rho=0.346$, $p=0.014$), so the patients with the densest natal cleft hair were also those presenting with the most complex tracts. This is biologically coherent, since loose hair is the material that drives pit formation and lateral extension in the first place, and it suggests that hair burden acts upstream of healing rather than directly upon it. Hair shaft thickness was the one candidate that failed even univariably, reaching neither parametric nor rank-based significance for healing time or for delayed healing; the apparent 8.6-day gap between thin and thick shafts rested on a single dispersed group of 15 patients. Together these findings position post-operative depilation as prophylaxis against new disease rather than as a means of accelerating the index wound.

***Recurrence***

The six-month recurrence rate of 6.0% lies at the favourable end of the reported spectrum. Meinero et al reported 5% after endoscopic treatment, while Dessily et al reported 14.9% at longer follow-up.[5,8] Emral et al reported recurrence in the 6-10% range in a comparison of laser ablation with crystallised phenol and in a dedicated evaluation of laser ablation for recurrent disease, and the meta-analysis by Qin et al. and the multicentre cohort of Sluckin et al. reached similar conclusions regarding durability.18-21 No predictor discriminated recurrence here, but with three events this is an absence of evidence rather than evidence of absence, and the six-month window is shorter than the interval at which many recurrences declare themselves.

***Limitations***

Several limitations qualify these findings. The single-centre design and modest sample of 50 patients limit generalisability, and while the study was adequate to detect differences in healing time, the 14 delayed-healing events and 3 recurrences left the binary analyses underpowered; logistic modelling was for that reason not attempted. The absence of a concurrent comparator arm means that comparisons with conventional excisional surgery rest on historical published data. Occupational sitting duration was self-reported, and hair density and shaft thickness were graded by the unblinded operating team without formal inter-observer reliability testing, so misclassification cannot be excluded. Body mass index spanned a narrow range with no obese patient, so the contribution of adiposity remains untested at the upper end. Pain was measured on a four-point rather than a continuous scale, limiting comparability, and follow-up was restricted to six months.

## CONCLUSION

Radial diode laser ablation at 1470 nm proved a safe, quick and well-tolerated treatment for sacrococcygeal pilonidal sinus disease, delivering a mean operating time of 26 minutes, a mean hospital stay of 1.3 days, minimal day-7 pain, complete healing at a mean of 28.5 days and

a six-month recurrence rate of 6.0% with no serious complication. Morphological stage was the dominant and only independent determinant of healing time, adding roughly 5.6 days per stage. Overweight status, prolonged occupational sitting and dense gluteal hair were each strongly associated with delayed healing on univariable analysis but lost independence once stage was accounted for, indicating that they act largely through more complex disease at presentation; hair shaft thickness predicted nothing at all. No factor predicted recurrence at six months. Early referral before lateral extensions develop is therefore the most effective lever on convalescence. Adequately powered multicentre studies with follow-up beyond one year are required to define the place of laser ablation against excisional surgery and to establish its long-term durability.

*Funding: No funding sources*
*Conflict of interest: None declared*
*Ethical approval: The study was approved by the Institutional Ethics Committee*

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**Cite this article as:** Singh A, Yadav GD, Yadav A. Beyond the scalpel: post-operative outcomes of radial diode laser ablation in sacrococcygeal pilonidal sinus disease. Int Surg J 2026;13:xxx-xx.