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Future of pilonidal cyst surgery: a comparative review of traditional and laser techniques

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Abstract

Pilonidal disease is a common sacrococcygeal cyst or sinus that can significantly impact patients' quality of life, necessitating an analysis of evolving treatments to optimize patient outcomes. This review compares traditional and minimally invasive techniques focusing on laser ablation, in treating pilonidal cysts, focusing on each method's effectiveness, recovery time, recurrence rates, complications, cosmetics, and costs. We conducted a comprehensive assessment of literature exploring PubMed, Scopus, Web of Science, Google Scholar, and Embase for studies comparing traditional surgical techniques including traditional excision with open and closed healing, flap reconstructions, with minimally invasive procedures focusing on laser-assisted. Although traditional surgical techniques were practical, but they were associated with a relatively high risk of wound complications, recurrence, extended healing periods, and poor cosmetics. Laser techniques showed promising results in reducing hospital stays (for at most 3 h vs. days), postoperative pain, and recurrence rates, with healing rates up to 97%. However, laser methods may be less effective in severe or complicated cases, and they have higher costs. Laser-assisted techniques offer a less invasive option compared to traditional surgery, with greater patient fulfillment. However, additional research is needed to optimize laser procedures, especially in complex cases, and to establish long-term outcomes. For simpler pilonidal cysts, laser treatments are a promising option that could eventually replace traditional surgery as the standard of care.

Keywords Pilonidal sinus, Laser ablation, Minimally invasive, Surgical flaps, Simple excision

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Introduction

Pilonidal cysts, first described by Herbert Mayo in 1833, are sac-like structures, typically form in the sacrococcygeal region and gluteal cleft which are often associated with hair and skin debris [1]. Although the main cause of the disease is not entirely clear, studies indicate that hair follicle obstruction, friction, and trauma may contribute (Fig. 1). Behaviors such as extended periods of sitting or heightened perspiration could intensify its development [2].

The incidence of pilonidal sinus disease is estimated to be 26 per 100,000 people, more frequent among ages 15 to 30 [3, 4]. Male gender, sedentary lifestyle, insufficient personal hygiene, and obesity are known potential risk

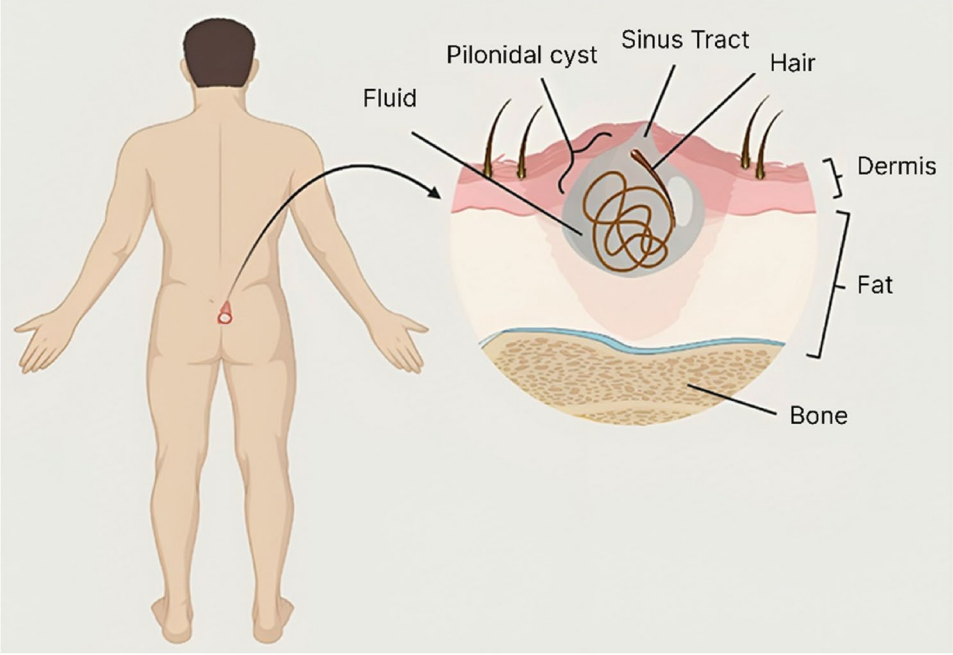

Fig. 1 A schematic view of pilonidal cyst

factors [5, 6]. Pilonidal cysts symptoms vary from localized pain in the sacrococcygeal region exacerbated by sitting or prolonged activities to abscess formation full of serosanguinous or purulent fluid [7].

Pilonidal disease can be classified into three forms: acute abscesses, sinus tracts, and complex disease with large, branching sinus tracts [8, 9]. The treatment depends on the manifestation, varying from supportive treatment for asymptomatic disease to surgery in chronic and complex cases. Disease manifestation, patient acceptability, and surgeon preference influence treatment. Laser and surgery indications are not currently well defined [9].

Pilonidal cysts can be treated using non-operative, operative, or both methods [10]. The operation is the treatment of choice in cases of secondary infections, pain, or chronic sinus tract problems. Over centuries, surgical interventions have been improved, and the older forms were more likely to result in recurrence [11]. More recent trends are towards minimally invasive procedures such as video-assisted treatments [12, 13].

To answer to the question of What are the indications for using each of the surgical and laser therapy methods in the treatment of pilonidal cysts? This review comprehensively discusses surgical techniques of pilonidal cyst treatments from traditional to the recent minimally invasive techniques with a focus on comparing advantages and disadvantages of laser technique and previous methods.

Methods

The purpose of this narrative review was to compare traditional surgical procedures versus laser-assisted approaches for treating pilonidal cysts. We conducted a comprehensive search of the literature in PubMed, Scopus, Web of Science, and Google Scholar to identify relevant research, with no time constraints and only English-language publications. Search criteria included "pilonidal cyst," "laser ablation," and other associated MeSH phrases. All studies that compared laser techniques and traditional pilonidal surgical interventions were included in this study. Data included sample size, surgical technique, recurrence rates, healing rate, postoperative complications, hospital stay duration, and cost analysis supporting the narrative synthesis. The methodological quality of the included studies comparing laser techniques with traditional surgical procedures was evaluated using the National Institute for Health and Clinical Excellence (NICE) checklist by two authors (M.R. and P.K.D.). Disagreements over the interpretation were resolved by the consultant with the third author (K.J.). The quality of the studies was determined as good (score = 7–8), fair (score = 4–6), or poor (score = 0–3). The quality assessment of the included studies using the NICE checklist and their scores is presented in supplementary Table 1 [23, 24].

Traditional surgical techniques

The standard approach for treating pilonidal disease involves skin and subcutaneous tissue, removing, suturing or open healing [25].

Table 1 Studies comparing laser techniques with traditional surgical procedures

Study	Year	Study design	Sample size	Techniques	Laser ablation vs. traditional techniques			Follow-up, months
					Healing rate	Recurrence rate	Complication rate	
Khubezov et al. [14]	2020	Comparative non-randomized	90	Laser ($n=30$) Primary closure ($n=30$) Open wound healing ($n=30$)	96.7% vs. 83.3% vs. 100%	3.3% vs. 16.7% vs. 0%	6.7% vs. 23.4% vs. 0%	12
Yardimci et al. [15]	2020	Prospective randomized	58	Laser + pit excision ($n=30$) Karydakis technique ($n=28$)	96.7% vs. 96.4%	3.3% vs. 3.6%	0% vs. 0%	mean, 25
Dalbas et al. [16]	2020	Prospective randomized	200	Laser ($n=100$) Limberg flap ($n=100$)	96% vs. 97%	4% vs. 3%	0% vs. 4%	12
Abdelnaby et al. [17]	2021	Prospective non-randomized	139	Laser ($n=62$) lay open ($n=77$)	90.3% vs. 100%	9.7% vs. 0%	13% vs. 18.2%	Median, 12
Hassan et al. [18]	2021	Prospective randomized	45	Laser ($n=15$) primary closure ($n=15$) flap reconstruction ($n=15$)	93.3% vs. 80% vs. 93.3%	6.7% vs. 20% vs. 6.7%	13.3% vs. 60% vs. 40%	3
Fernandes et al. [19]	2022	Retrospective non-randomized	106	Laser + pit-picking ($n=36$) sinusectomy ($n=70$)	67% vs. 83%	17% vs. 15.7%	17% vs. 4%	Median, 10
Algazar et al. [20]	2022	Prospective non-randomized	71	Laser ($n=24$) Limberg flap ($n=47$)	95.8% vs. 100%	8.3% vs. 4.3%	20.83% vs. 12.8%	Mean, 13.87 ± 4.52 14.46 ± 4.36
Gratiashvili et al. [21]	2024	Prospective non-randomized	152	Laser + limited excision ($n=76$) wide excision ($n=76$)	97.4% vs. 100%	7.9% vs. 1.3%	3.9% vs. 1.3%	Mean, 28
Tyrväinen et al. [22]	2024	Retrospective non-randomized	278	Laser ($n=66$) direct closure ($n=134$) flap reconstruction ($n=78$)	67.7% vs. 66.4% vs. 56.4%	3.1% vs. 7.5% vs. 11.7%	12.1% vs. 26.9% vs. 34.6%	Mean, 15.4 ± 7.6 85.2 ± 39.8 87.6 ± 29.3

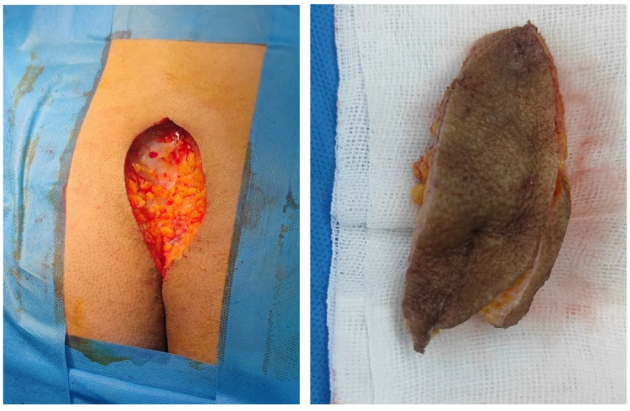

Fig. 2 Wide excision and healing by secondary intention

Incision and drainage

A simple incision and drainage are a straightforward surgery that entails creating an elliptical midline cut in the abscess, and curettage of the dead tissue [26]. However; the recurrence rate has been 40–60% requires a second procedure to reduce to 15% [27, 28].

Wide excision and healing by secondary intention

This method involves removing an elliptical wedge of skin and subcutaneous tissue extending down to the presacral fascia (Fig. 2). The aim is to eliminate debris and inflammatory tissue, facilitating wound healing through granulation and regular wound care and discomfort of packing is necessary to complete wound healing [1, 29]. The procedure should be done under general anesthesia, and in addition to a few days of hospital stay, healing takes 8–10 weeks [1, 30].

Marsupialization and Lay open

Deroofing the sinus in marsupialization reduces the wound healing time by involving an elliptical incision and en bloc excision of healthy tissue [31]. Excision with marsupialization is effective in treating abscesses reduces the size of the wound in the middle, speeded up the healing process and has a reported recurrence rate of less than 13% [32].

Excision and primary closure

An elliptical incision encompassing all the external orifices is done to remove the sinus up to the fascia and a healthy tissue remain [31, 33]. Following the drain placement into the cavity, the subcutaneous tissue is approximated using absorbable sutures for presacral fascia and non-absorbable stiches for the skin [34]. Primary closure compared to secondary intention healing is thought to be more aesthetically pleasing, and provide faster wound healing [35, 36].

Excision with reconstructive flaps

The recovery following flap-reconstructions is said to be satisfactory, but these procedures are also linked to extended hospital stays and prolonged recovery periods [14]. The most frequent applied flap reconstructions are

as follows [37–39]: (I) Karydakis flap with an elliptic incision 2cm from the median line were the induration is palpable is displaced to the side of the secondary orifice [40]. Following tissue resection, a subcutaneous fat flap is sutured to the retrosacral fascia and raw surfaces using a suction drain emplacement [41]. (II) Bascom flap, also called cleft lift procedure, is a modified Karydakis procedure in which although the diseases tissue is removed, avoiding wide excision, the deep tissues remain. The flap in this technique is only a few millimeters, thinner than Karydakis [42]. (III) Limberg flap is done under spinal anesthesia, the involved sacral area is excised to the fascia of the sacrum. Then, the flap provided from one of the gluteal regions is placed. A suction drain is also performed through a separate incision [43].

Advantages and disadvantages of traditional techniques

The open approach takes an extended time and involves leaving the wound exposed for subsequent closure, resulting in an extended healing period; nevertheless, is linked to markedly reduced rates of recurrence compared to closed healing [44, 45]. High indirect and direct costs associated with patient care, days off work, and wound care, are also the down side [46].

Early recurrence occurs when sinuses aren't identified during surgery, while late recurrence is caused by hair, debris, inadequate wound care, infection, or hair removal [47–50]. Allen-Mersh et al. reported recurrence rates of 13% one year after using open techniques, and 15% after excision and closure [47]. However, the potential benefit is counteracted by the increased likelihood of wound dehiscence and infection. Previous publications have identified obesity and smoking as an independent risk factor for recurrence [51–53].

Excision followed by flap closure has better outcomes, reduced complications, and lower recurrence rates [54]. A meta-analysis underlying 5-year recurrence of 10% for off-midline compared to 16.8% for midline closure [55]. Asymmetric excision with Karydakis and Bascom techniques reduces complications A meta-analysis underlying 5-year recurrence of 10% for off-midline compared to 16.8% for midline closure [55].

Overall, regarding radicality and difficulty of performing these surgical procedures, they are characterized by higher risk of complications. Moreover, they all should be performed in operation room, under local or general anesthesia, and recurrent chronic patients might need plastic flaps [56]. Additionally, the cosmetic scores are poor, and the scar would remain life-long [57].

Laser technique; a novel minimally invasive intervention

New minimally invasive techniques, such as laser treatment, have been developed with promising results and satisfactory patient outcomes [58, 59], was first described by Lord and Millar in 1965 [60], and years after, Bascom presented pit-picking technique [61]. Fibrin-glue, phenol, endoscopic treatment, Gips technique using trephines, and laser are commonly applied in pilonidal disease patients [44, 62–65].

LASER (Light Amplification by Stimulated Emission of Radiation) is a device emitting one wavelength of electromagnetic radiation applied for cutting, coagulating, or ablating tissues in various clinical applications [66]. Its monochromatic beams deliver high energy density, converting light to heat, transferring heat, and causing tissue reaction [67].

Laser therapy methods and types vary, with Ruby (694 nm), Nd: YAG (1064 nm), Er: YAG (2940 nm), diode (630–980 nm), argon (350–514 nm), CO2 (10,600 nm), and pumped-dye (504–690 nm) being the most common [68]. Diode and Nd: YAG lasers are more common for ablation, with settings like 1470 nm and 8–15 W. The probe exit speed is 1 mm/s, causing sinus contraction and closure [69]. In the Karita study, a radial laser probe was placed in the sinusoidal duct, while the probe was delivered with an exit velocity of 1mm/s and an energy of 10 or 13 watts [26]. Also, in another study conducted by Williams and colleagues, the NeoV V1470 Diode Laser (neoLaser Ltd, Caesarea, Israel) with a 2-mm probe with a median operative time of 30 min was used [70].

Since the 1990 s, laser therapies have been applied in different rectal diseases such as hemorrhoids, anal fistulas, pilonidal cysts, and anal intraepithelial neoplasia [71, 72]. To address pilonidal sinus, Sinus Laser Therapy (SiLaT), Sinus Laser-Assisted Closure (SiLaC), Pilonidal Disease Laser Treatment (PiLaT), and the most recently, Laser-Assisted Endoscopic Pilonidal Sinus Treatment (LEPSiT) were used [13]. The SiLaT procedure involves hair extraction, sinus debridement, and sealing of the sinus cavity using a diode laser [17]. SiLaC could be performed at any stage of the disease using a diode laser probe (Figs. 3 and 4) [59]. Diode lasers are semiconductor lasers that employ a thin doped layer on the surface of a crystal wafer as their active medium, emit light in the range of 800 to 1000 nm [73]. Moreover, the PiLaT technique, which is similar to SiLaC, uses a diode laser aimed at reducing and ablating pilonidal cysts but differs in its energy settings and focuses on walling off pilonidal tracts and cysts [74]. A newer approach, laser pilonidotomy, involves using a laser to ablate the sinus tract, with multiple incisions made to facilitate collected fluid drainage. This technique has shown efficacy in achieving complete wound closure and rapid healing, with a relatively low recurrence rate of 3.24% and a success rate of 97% [75].

Laser procedures can be performed under spinal, local, or general anesthesia. They involve identifying sinus orifices, removing hair, and removing the fiber. Laser energy destroys the sinus epithelium and obliterates the tract.

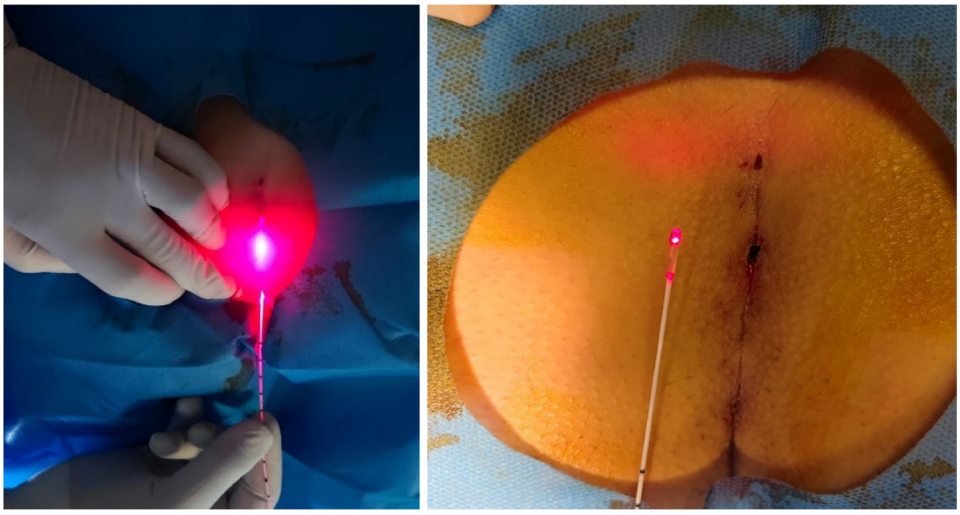

Fig. 3 Diode laser used in pilonidalotomy

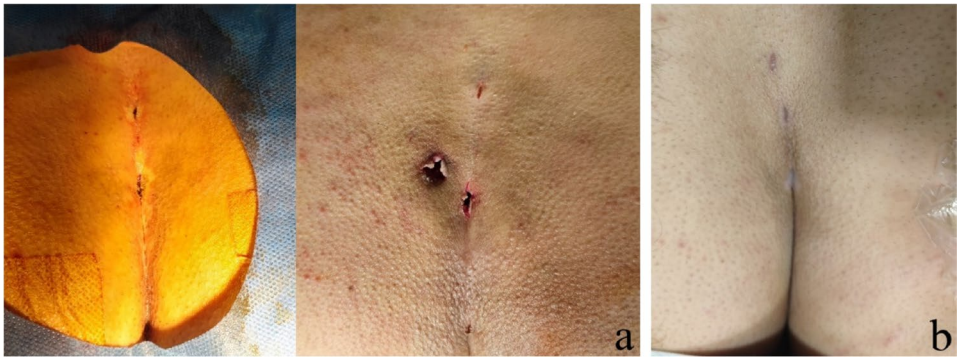

Fig. 4 Post-operative follow-up of laser surgery. **A** early post-operative laser technique **B** follow-up after weeks

After withdrawing the probe, tracts can be debrided and flushed with hydrogen peroxide or saline [76].

In addition to laser cyst ablation, lasers can be used for removing hair within the intergluteal cleft and surrounding sacrococcygeal region, pre-/post-surgery. A systematic review of laser epilation in patients with pilonidal disease, reported recurrence rates of pilonidal cysts from 0 to 28% during a follow-up period of six months to five years [77]. The hair removal also has exhibited potential efficacy in diminishing postoperative recurrence rates following wide excision or pit-picking surgical procedures [78].

Advantages and disadvantages of laser technique

Patients generally chose less invasive approaches over wide excision that provide a better quality of life and higher rates of satisfaction [79]. Ease of learning the approach is also an advantage for both surgeons and patients.

In a systematic review on pilonidal disease laser treatment consisting 971 patients, Romic et al. reported a primary healing rate of 94.4%, a weighted average recurrence rate of 3.8%, and a weighted average complication rate of 10%, most of which were mild [76]. Mostly reported complications were infection ($n=47$), seroma ($n=14$), hematoma ($n=10$), and abscess ($n=9$) which were all solved with antibiotics and/or ambulatory therapies. A meta-analysis by Xie et al. including 1214 patients undergone laser therapy showed that 84.4% of patients achieved healing with mean complication and recurrence rates of 12.7% and 7.6%, respectively [80]. The results of a multicenter cohort study on patients with pilonidal disease treated with SiLaC revealed success rates of 66% after one procedure, 92% after two procedures, and 98% after three procedures [81]. Another investigation on 237 individuals with pilonidal disease treated by SiLaC reported that 193/237 patients (92.8%) started daily activities immediately after hospital discharge with the median time of hospital stay was 3 h. The median operation time was also as short as 24 min [82]. Another key advantage of laser surgery is the repeatability in cases of recurrence, depending on patient characteristics and disease severity. Two short-term studies with relatively large sample sizes demonstrated that repeated laser treatments

might be necessary to achieve optimal healing rates [81, 83]. Regarding lower bleeding amounts, laser ablation was also chosen for pilonidal disease over normal excision in a 15-year-old hemophilic A patient [84].

Nevertheless, laser technique also has considerable disadvantages. The blind nature of this procedure and lack of direct access may result in incomplete ablation of the sinus, and missing abscesses or deep tracts [85, 86]. Moreover, laser technique is completely surgeon-dependent. In moving the probe, a slow speed could burn the surrounding tissues, while a high speed would not burn the lining epithelium of the sinus sufficiently [87]. Of note, adequate specimen cannot be obtained for pathohistological analysis via laser probe, even though malignant pilonidal degeneration is quite rare [76, 88]. In term of costs, at first look, the procedure seems more expensive than other available techniques. Nonetheless, less pain-killer consumption, hospital stays, post-operative care, and time off work significantly offset the expense of laser pilonidalectomy [87]. Further investigations are necessary to evaluate the cost-effectiveness of laser technique in comparison to traditional.

Comparing laser ablation with traditional techniques; which one is more beneficial?

The ideal therapeutic approach would be the one that is safe, effective, and well tolerated, with a reasonable cost, and optimal cosmetic outcome [89]. Several studies have compared laser ablation with further operating techniques as shown in Table 1. Despite numerous investigations, the most effective treatment for recurring pilonidal sinus remains a debate [79, 90].

Efficacy; healing, reoccurrence, and complication rates

A study by Khubezov et al. compared three patient groups: primary closure, laser ablation, and excision with open wound healing. The control group had no complications, while the laser ablation group had lower rates and less hospital stay [14]. A prospective, randomized study comparing the Karydakis procedure with pit excision and laser ablation in patients with early-stage pilonidal disease by Yardimci et al., should slightly higher healing rates, lower recurrence rates, as well as no complication in laser group [15]. Furthermore, in a retrospective comparative study of 139 subjects, Abdelnaby et al. compared laser ablation with open lay surgery, advantages were in terms of faster healing, and improved quality of life, though it had a lower primary healing rate of 90.3% compared to 100% at 12 months follow-up [17]. Future studies should be performed with lengthier follow-up to elucidate the long-term outcomes of both strategies.

A prospective randomized trial on 45 patients with pilonidal disease confirmed lower post-op complications in laser subjects compared to primary closure and flap reconstruction (13.3% vs. 60% vs. 40%); however, they showed 93% healing and 6.7% recurrence rates similar to flap reconstruction group [18]. Another study comparing laser, direct closure, and flap approaches delineated higher healing rates (67.7% vs. 66.4% vs. 56.4%), as well as lower recurrence (3.1% vs. 7.5% vs. 11.7%) and complications (12.1% vs. 26.9% vs. 34.6%) in minimally invasive group [22]. However, follow-up duration of patients was different (15.4 ± 7.6; 85.2 ± 39.8; 87.6 ± 29.3 months, respectively). Furthermore, a prospective non-randomized study by Gratiashvili et al., compared two groups of individuals with pilonidal disease; (I) laser + minimal excision ($n = 76$); (II) wide excision ($n = 76$). Healing rates was lower in the laser assisted group (97.4% vs. 100%); however, the duration was significantly lower (6.5 ± 2.4 vs. 14.5 ± 2.6 weeks, respectively). Although recurrence and complication rates were higher (7.9% vs. 1.3%; 3.9% vs. 1.3%), they were not statistically significant [21].

Dalbas et al. reported that although lower complications (0% vs. 4%) in patients undergone laser technique compared to Limberg flap, healing (96% vs. 97%) and reoccurrence (4% vs. 3%) rates were rather the same [16]. Algazar et al. found that laser therapy reduced postoperative pain, hospital stays, and operative time compared to SiLaT. However, SiLat had higher recurrence and complication rates, with simple seroma complications. Limberg flap complications required vacuum assisted therapy [20]. The lower primary healing could have been due to refusal of the second laser session in one patient who chose flap technique. Additionally, authors also concluded that regarding the disadvantages of blind innate of obliterating via SiLat, the near healing rates between the two groups were comparable, suggesting the effectiveness of the minimally invasive intervention.

Consistenetly, Brown et al. found that minimally invasive procedures improved quality of life, reduced pain, and improved return to normal life, but led to higher treatment failure compared to major excisional surgeries [89]. To identify factors affecting healing following laser therapy, Harju et al. revealed that spillage of pus during the procedure was significantly associated with lower healing rate (53% vs. 93%) [64]. According to Dessily et al., the presence of secondary orifices (24.6% vs. 56.6%), postoperative complications (19.2% vs. 40%), and particularly postoperative infection (8.8% vs. 30%) were associated with the higher recurrence and failure rates [59]. Consistently, Spindler et al. demonstrated that laser treatment may be less effective for overweight patients and those with multiple secondary openings associated with pilonidal pits [91]. Moreover, among 307 patients treated for pilonidal sinus, BMI ≥ 30 was independently associated with time to cyst recurrence [92].

Cosmetics

There are few studies addressing cosmetic aspect of pilonidal surgery. Laser technique showed the best cosmetic outcome and patient satisfactory. Excision and open wound healing showed the worst cosmetic result in comparison to laser ablation and primary wound closure (visual analog scale (VAS) of 4.4 vs. 8.9 and 7.2) [14]. Over-treatment in recurrent cysts also worsen unacceptable cosmetic outcomes. Consistently, another retrospective investigation on SiLaT and lay open treatments, laser ablation had better cosmetic results, and importantly, higher quality of life scores [17]. A study comparing SiLaC and Limberg Flap techniques showed that alongside of lesser postoperative pain and hospital stay, and faster healing with better cosmetic outcomes [93].

Costs

Pilonidal disease treatment costs can increase due to complications and treatment failure. The median cost for treatment ranges from $281 for antibiotics to $686 for incision and drainage. Surgery is more cost-effective for persistent symptoms, however, the study did not consider minimally invasive surgeries or variable healthcare costs [53]. Similarly, Algazar et al., compared laser treatment and flap, patients mostly chose Limberg flap to avoid 800$ for each fiber of SiLaC technique, suggesting a significant barrier to novel technology in developing countries [20]. Patients afflicted with pilonidal disease are generally within the working-age demographic and are economically active.

Studies show financial expenditure for pilonidal cyst treatment varies based on treatment modality, healthcare institution, and insurance reimbursement, with conservative management costing $500–2000 and surgical excision $3000–6000 [94]. Flap procedures, like Karydakis and Limberg flaps, are costly, ranging from $10,000 to $30,000. These costs are attributed to procedural complexity, prolonged operative time, post-operative care, and indirect costs [68, 95].

Delayed healing and return to normal activities can lead to diminished economic productivity and potential dependence. Although laser techniques are more expensive but have lower complementary costs like wound healing, resting, visits, painkillers, and day off work. Further research is needed to address cost effectiveness and insurance support for hair removal and ablations.

A comprehensive economic assessment and comparison of treatment expenditures are crucial for understanding the financial implications of managing pilonidal disease, with conservative approaches costing between $500 and $2000 [53], more intricate interventions markedly elevate financial commitments. For instance, Surgical excision costs $3000-$6000, while flap procedures like Karydakis or Limberg may cost $10,000-$30,000, depending on procedure complexity and post-operative care need [33]. In contrast, laser therapies such as SiLaC, while initially incurring greater expenses, at a rate of $800 per fiber [20], may ultimately present enhanced cost-effectiveness over the long term due to their fewer recurrence rates, abbreviated recovery durations and a reduced necessity for follow-up consultations.

Table 2 A summary of treatment techniques for pilonidal cyst, recovery time, and recurrence rates

Treatment Technique	Recovery Time	Recurrence Rate	Ref
Conservative Management	40-50 days	0-58.2%	[96–100]
Excision with Primary Closure	10-20 days	0-67.9%	[96, 101–104]
Incision and Drainage	13-30 days (average 3 weeks)	40-60%	[6, 27, 28]
Laser Treatment (SiLaC)	15 days-6.5 weeks	0 - 26.4%	[21, 26, 59, 105, 106]
Flap Procedures (Karydakis, Limberg)	Limberg: 11.6-23.3 days Karydakis: 8-28.6 days	Limberg: 0-23.3% Karydakis: 0-6%	[33, 107–111]
Flap Procedures (Modified)	Limberg: 14-32.6 days Karydakis: 23.5 days	Limberg: 0- 5.4% Karydakis: 0-5.7%	[33, 112–117]

Overall, several studies have suggested that one method is more effective than another; however, many of them have remarkable limitations. Small sample size, short-term follow-up, absence of control group, lack of randomization, retrospective design, and the lack of the classification of pilonidal disease severity such as recurrent or abscess formation. Studies did not discuss contraindications of laser or traditional surgeries in different patients. Previous studies also failed to assess other risk factors associated with wound healing such as comorbidities, patient compliance, and costs of different treatment techniques has not been investigated yet. A good compliance is the key to prevent the relapse, highlighting the importance of personalized approach [96]. Finally, healthcare costs vary significantly across countries and institutions. The relevant studies were all based on costs, and reported no formal economic appraisal or cost-effectiveness modelling. Despite the advantages of laser ablation, in patients with high risk of infection, as well as low compliance, open wound technique cannot be avoided. Since the study was hindered by conflicting results, there is still a long way to prepare a guideline for standard approach to pilonidal cyst. Nevertheless, anorectal surgeons should develop the most satisfactory individualized plan based on patients' situation (Table 2).

Future directions and limitations in pilonidal cyst surgery

Laser technology improved traditional surgical methods, particularly for the management of pilonidal cyst disease after 2019 [118]. Although laser ablation affords improved satisfaction, quicker healing, and improved cosmetics compared to open surgery, the recurrence and complication rates have not validated.

The high cost of laser treatment for pilonidal sinuses is a significant drawback. Moreover, there has been reports of unexpected pus release during surgery which may cause contamination. This highlights the importance of patient's condition in choosing the best personalized approach. Laser procedure seems a better choice for simple pilonidal sinuses [64], but concerns remain about long-term efficacy and safety due to lack of data.

Combining minimally invasive techniques can reduce wound complications, recurrence rates, hospital stays, and time to return to daily activities. Studies show that adding platelet-rich plasma to laser therapy can increase complications rates [119]. Combining laser therapy with endoscopic pilonidal sinus treatment can reduce surgery time, accelerate wound healing, and decrease postoperative pain [120, 121].

Research found that endoscopic treatment improves healing rates and patient satisfaction compared to laser surgery. However, complications were higher in the endoscopic group [122, 123]. While the combination of laser and endoscopic interventions improved surgical outcomes, in addition to worsened healing and complication rates compared to cautery-phenol and endoscopic treatment, the results were not statistically insignificant [124].

There are some limitations in this review that should be acknowledged. First, this study is a narrative review that is limited to reports in English. Second, some of the included studies had fair quality. Retrospective non-randomized studies were also included to conduct a comprehensive review. Future systematic review and meta-analysis studies focusing on prospective randomized trials could be beneficial. In addition, Comparative large-scale, multi-center, prospective, randomized clinical trials and review studies between laser therapy and other surgical methods, including other non-invasive techniques, can also be helpful. Third, we did not include additional variables, such as operation time, length of hospital stay, time to return to work, and cost of the postoperative course. Despite the significant advantages of laser techniques, their availability at care facilities and the presence of skilled physicians are limiting considerations, resulting in a scarcity of large studies. A more detailed examination of the costs and learning curve of laser endoscopic methods will be among the points that can be questioned in future studies [1, 76]. Fifth, since the included studies reported follow-up periods with various statistical metrics (range, mean, and median), there was a need to use advanced statistical methods to evaluate the effect of different follow-up periods on patients' outcomes, which was extensive beyond the scope of a single study. It could be an interesting idea for future review studies. Laser procedures have been described to reduce the healing time, but there is no guideline available in the literature based on patient condition, extent of disease, presentation, cost-effectiveness, experience of surgeon, and complications.

Conclusions

This study comprehensively reviewed the trend toward minimally invasive laser surgery for treating pilonidal cysts and highlights the advantages of rapid recovery, higher patient satisfaction, and lower recurrence rates. Rapid recovery leads to optimized patient's daily activity and in compare to invasive methods such as complete excision, could result in an improved patient's quality of life. Although the cost-effectiveness varies across studies, it is possibly lower in laser method due to absence of systemic anesthesia and its feasibility to be performed in a clinic with average facilities rather than an OR. Further studies are required to optimize laser procedures as a personalized treatment approach. Conducting multicenter, controlled, and long-term studies, could provide a better standardized approach to treat pilonidal cyst regarding the cyst's characteristics. These endpoints could comprehensively make a comparison from minimal invasive laser surgery to conventional treatments.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12893-025-03222-y.

Supplementary Material 1

Authors' contributions

Kimia Jazi: Conceptualization, Data interpretation; Amirhossein Larijani: Study Selection, Data extraction, Writing – original draft; Marzieh Rahimi: Data extraction, Writing – original draft; Erfan Rajabi: Study Selection, Data extraction, Writing – original draft; Pouya Karami Dehkordi: Study Selection, Data extraction, Quality assessment, Fatemeh Askari Yazdian: Methodology, Writing – review & editing;; Naeim Nourozi: Writing – original draft, Abolfazl Nikkhoy: Study Selection, Data extraction, Writing – original draft, Babak Sabet: Supervision, Methodology, Conceptualization.

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Data availability

No datasets were generated or analysed during the current study.

Declarations

Competing interests

The authors declare no competing interests.

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