# Comparative analysis of surgical techniques for pilonidal disease: Differentiating between recurrence and persistent wound failure

Original Article

*Amro Elhadidi, El-Sayed Abdullah, Mohamed Shetiwy and Mohammed Al-Katary*

*Department of Surgery, Mansoura University, Mansoura, Egypt.*

## ABSTRACT

**Background:** Pilonidal disease (PD) presents with a spectrum of clinical manifestations, ranging from symptomatic abscesses to troublesome hair-containing sinuses. Two common postoperative complications, recurrence and persistent wound failure, can be challenging to distinguish. We consider these complications as distinct entities that require different management approaches. This retrospective study aims to clarify our findings by comparing various surgical methods for PD.

**Patients and Methods:** A total of 410 patients underwent three distinct surgical techniques. Various statistical analyses were performed to identify correlations between variables. The groups of recurrence and postoperative persistent wound failure were examined as separate surgical outcomes.

**Results:** Over 80% of patients achieved complete healing from PD. Excision with marsupialization was performed in 38% of patients. Complete wound healing with no evidence of recurrence was observed in 331 patients (mean follow-up: 42.29±10.41 weeks). Recurrence occurred in 24 patients (mean follow-up: 14.25±6.05 weeks), while postoperative persistent wound failure occurred in 55 patients (mean follow-up: 7.49±4.86 weeks). The SF-36 analysis revealed higher mental health and bodily pain scores in patients with complete wound healing compared to those with recurrent disease and persistent wound failure.

**Conclusion:** Recurrence and postoperative persistent wound failure are distinct outcomes following the surgical treatment of PD. Differentiating between these postoperative outcomes is essential for accurately estimating recurrence rates and exploring targeted therapies to manage complications and reduce recurrence.

**Key Words:** Persistent wound failure, pilonidal sinus, recurrence, retrospective study, surgical methods.

**Received:** 5 August 2024, **Accepted:** 4 September 2024, **Published:** 1 January 2025

**Corresponding Author:** Amro Elhadidi, MD, Department of Surgery, Mansoura University, Mansoura, Egypt. **Tel.:** 00201556559787, **E-mail:** amrohadidy@mans.edu.eg

**ISSN:** 1110-1121, January 2025, Vol. 44, No. 1: 200-206, © The Egyptian Journal of Surgery

## INTRODUCTION

Pilonidal sinus is a common and often distressing condition characterized by the formation of sinus tracts or cysts, typically located in the natal cleft of the sacrococcygeal area. Affecting ~25 out of every 100 000 individuals, pilonidal disease (PD) is a challenging acquired disorder[1]. The spectrum of PD presentation includes acute abscesses, chronic sinuses with ongoing suppuration, and/or extensive subcutaneous tracts. Asymptomatic pits that do not require treatment are also possible[2]. Although PD predominantly affects men, females often receive diagnoses earlier due to the earlier onset of puberty[3,4]. The primary treatment modality for this condition is surgical intervention, utilizing a variety of surgical techniques[5]. The goals of treatment include closing the resultant defect and completely excising the affected tissue. However, the surgical management of pilonidal sinus disease is complicated by high rates of wound infection, poor wound healing, and subsequent disease recurrence[6,7]. Despite various attempts to reduce such postoperative complications, no single approach has been universally successful.

Our study focuses on a comprehensive comparative analysis of different surgical methods for PD, specifically distinguishing between postoperative persistent wound failure and true recurrence. This analysis includes patients with pilonidal sinus who underwent open surgery, surgery combined with wound marsupialization, or excision and primary closure.

Our findings aim to provide evidence-based recommendations on the optimal surgical strategy for different patient categories and to offer insights into the recurrence rates associated with each surgical technique. Additionally, we emphasize the significant issue of postoperative persistent wound failure as a distinct pathology that requires targeted therapy.

*DOI: 10.21608/EJSUR.2024.309919.1152*

## PATIENTS AND METHODS:

### *Study design and patient population*

A retrospective cohort analysis was conducted at Mansoura University Hospital, a tertiary care facility, over a 4-year period from 2020 to 2024. The study included 410 patients who underwent one of three primary surgical treatments for pilonidal sinus:

(1) Open surgery: this technique involves wide excision of the pilonidal sinus and surrounding tissue, followed by allowing the wound to heal by secondary intention.

(2) Excision with marsupialization: this method involves the surgical removal of the pilonidal sinus and associated tracts, followed by suturing the wound edges to the underlying tissue, creating a "pocket" that allows the wound to heal from the inside out.

(3) Primary closure: in this approach, the pilonidal sinus and its associated tracts are excised, and the wound is directly closed with sutures, aiming for immediate closure and healing.

**The patients were categorized based on the surgical method they received. Our study classified patients into three distinct categories**:

(1) Complete wound healing: patients achieve full resolution of the disease, and the wound heals completely during the follow-up period (Fig. 1).

(2) Recurrent PD: patients initially experienced complete wound healing following surgery, but subsequent follow-up examinations revealed new or residual pits, with or without persistent wound failure (Fig. 2a, b).

(3) Postoperative persistent wound failure: characterized by ongoing symptoms and complications despite the initial surgical treatment, postoperative persistent wound failure occurs without evidence of true recurrence, such as the development of new pits (Fig. 3a, b).

**Fig. 1:** Optimal wound healing following surgical treatment of pilonidal disease, illustrating complete resolution of the affected area.

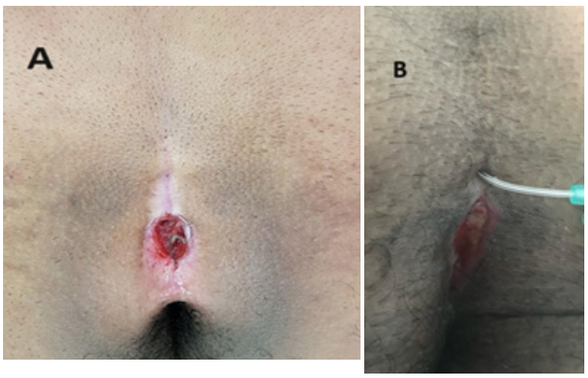


**Fig. 2:** (a, b) Evidence of recurrent pilonidal disease showing multiple pits postsurgery, indicative of disease recurrence.

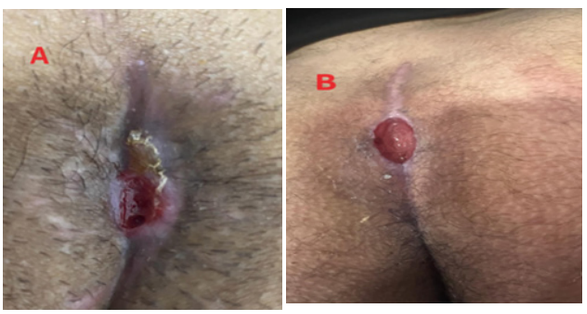


**Fig. 3:** (a, b) Persistent wound failure observed during long-term follow-up, demonstrating ongoing complications despite initial surgical intervention.

All patients were interviewed via e-mail, phone, or in person. Following surgery, the Short Form 36 scale was administered with the patient's consent. The Short Form 36 is a widely used tool for assessing health quality and is recognized as the "gold standard" for numerous illnesses.

Its purpose is to evaluate a patient's total health-related quality of life in eight major areas. These categories consist of:

**Physical functioning:** assesses the capacity to carry out movements like walking or stair climbing.

**Role limitation due to physical problems**: measures how physical health issues limit work or other daily activities.

**Role limitation due to emotional problems**: evaluates the influence that emotional issues (such depression or anxiety) have on day-to-day functioning.

**Social functioning**: determines the degree to which mental or physical health problems impede regular social interactions.

**Mental health**: assesses overall mental health, including anxiety and depressive symptoms.

**Energy and vitality**: evaluates energy and weariness levels.

**Bodily pain**: assesses the degree to which pain interferes with daily activities as well as its intensity.

**General health perception**: evaluates an individual's overall belief about their personal health.

The Short Form 36 scoring procedures were employed to encode, aggregate, and transform item scores for each domain into a scale that spans from 0 to 100. Higher scores indicate superior health outcomes.

### *Data collection*

Pertinent information was gathered for each patient through a comprehensive assessment of electronic medical records. Data included demographic information, presenting symptoms, comorbidities, laboratory tests (including C-reactive protein and white blood cell count), type of initial operation, and total procedure cost. Trained researchers collected the data and entered it into a secure database. To exclude other conditions like suppurative hidradenitis, tuberculosis, herpes simplex virus, HIV, and inflammatory bowel disease (especially Crohn's disease), preexisting risk factors (such as smoking) that increase the likelihood of procedure failure or recurrent illness were also identified. Patients were followed up regularly at 6 months, 1 year, and then annually for 5 years.

### *Data analysis*

This study characterized the participants' baseline characteristics and distribution among the surgical methods. Descriptive statistics were used to summarize the data, and the P value was observed to establish correlations between variables.

### *Ethical considerations*

The Ethics Committee of Mansoura University Hospitals granted ethical approval for this study. All procedures were carried out in accordance with the ethical standards of the institutional and/or national research committee, the 1964 Helsinki Declaration and its subsequent amendments, or comparable ethical standards.

## RESULTS:

After successfully categorizing 410 patients, the distribution pattern across the three predetermined categories is presented in (Table 1). It was found that 80.73% of patients (331 out of 410) achieved complete healing from PD. In the recurrent PD category, a small percentage, 5.85% of patients (24 out of 410), exhibited symptoms. In the persistent wound failure category, 13.41% of patients (55 out of 410) were affected. The highest incidence of recurrent PD occurred in the 20–30 age group, comprising 62.5% of cases (15 patients).

Patient assessment data according to the surgical procedures is shown in a pie diagram in (Fig. 4). The analysis revealed that the study population underwent three major surgical operations: open surgery, excision with marsupialization, and primary closure. Specifically, 34.14% (140 out of 410) underwent open surgery, 37.80% (155 out of 410) underwent excision with marsupialization, and 28.04% (115 out of 410) underwent primary closure.

When examining the relationship between patient category and type of surgery, it was observed that among the completely healed patients (331 in total), 118 (84.28%) underwent open surgery, 134 (86.45%) underwent excision with marsupialization, and 78 (67.82%) underwent primary closure. Among the patients with recurrent disease (24 in total), seven (5%) underwent open surgery, five (3.22%) underwent excision with marsupialization, and 12 (10.43%) underwent primary closure. For the persistent wound failure patients (55 in total), 16 (11.42%) underwent open surgery, 15 (9.67%) underwent excision with marsupialization, and 24 (20.86%) underwent primary closure.

### *Descriptive analysis*

The results of the descriptive analysis comparing the three different categories of patients are represented in (Tables 2–4). According to the data in (Table 2), the scores (mean±SD) for healthcare costs ($), physical functioning, role limitation due to physical problems, social functioning, energy and vitality, general perception of health, bodily pain, follow-up duration (weeks), and dressing duration (weeks) between the categories of complete wound healing and recurrent disease are statistically significant ($P<0.05$). Other variables were not statistically significant.

Table 3 shows that the scores (mean±SD) for healthcare costs ($), physical functioning, role limitation due to physical problems, social functioning, mental health, role limitation due to emotional problems, energy and vitality, bodily pain, follow-up duration (weeks), and dressing duration (weeks) are statistically significant ($P<0.05$) between patients with complete wound healing and those with persistent wound failure.

Table 4 compares patient outcomes for recurrent PD and chronic wound failure. The study shows that the scores (mean±SD) for all parameters, except bodily pain, show statistically significant differences ($P<0.05$) between the two groups. Significant variations were discovered in age, healthcare costs, physical functioning, role limitation owing to physical problems, social functioning, mental health, role limitation due to emotional problems, energy and vitality, follow-up duration, and dressing duration. These findings illustrate the significant variations in patient outcomes for recurrence and permanent wound failure.

**Table 1:** Number and percentage of patients categorized into three distinct groups following pilonidal disease surgery: complete wound healing, recurrence, and persistent wound failure

| Total number of patients (*n*) | Complete wound healing | Recurrence of pilonidal disease | Persistent wound failure |
|---|---|---|---|
| 410 | 331; 80.73% | 24; 5.85% | 55; 13.41% |

**Table 2:** Comparative descriptive analysis of patient outcomes between those with complete wound healing and those with recurrent pilonidal disease, including statistical significance (*P values*)

| Parameters | Complete wound healing | Recurrence of pilonidal disease | *P* value |
|---|---|---|---|
| Age | 26.07±6.00 | 24.04±4.96 | 0.1067 |
| Sex (male/female) | 329/2 | 23/1 | |
| Healthcare costs ($) | 1.31±0.09 | 1.99±0.28 | <0.0001 |
| Physical functioning | 67.20±4.93 | 53.38±5.11 | <0.0001 |
| Role limitation due to physical problems | 64.10±7.08 | 55.29±5.23 | <0.0001 |
| Social functioning | 69.92±5.81 | 61.58±5.27 | <0.0001 |
| Mental health | 54.03±7.35 | 51.54±5.64 | 0.1052 |
| Role limitation due to emotional problems | 49.31±10.41 | 50.42±6.38 | 0.6069 |
| Energy and vitality | 79.74±6.99 | 54.42±5.24 | <0.0001 |
| General perception of health | 55.65±7.85 | 59.21±4.08 | 0.0286 |
| Bodily pain | 70.11±6.76 | 51.29±2.59 | <0.0001 |
| Follow up (week) | 42.29±10.41 | 14.25±6.05 | <0.0001 |
| Dressing week | 2.24±0.70 | 2.96±0.85 | <0.0001 |

**Table 3:** Comparative descriptive analysis of patient outcomes between those with complete wound healing and those with persistent wound failure, including statistical significance (*P values*)

| Parameters | Complete wound healing | Persistent wound failure | *P* value |
|---|---|---|---|
| Age | 26.07±6.00 | 27.16±5.49 | 0.2077 |
| Sex (male/female) | 329/2 | 54/1 | |
| Healthcare costs ($) | 1.31±0.09 | 1.66±0.15 | <0.0001 |
| Physical functioning | 67.20±4.93 | 50.11±4.62 | <0.0001 |
| Role limitation due to physical problems | 64.10±7.08 | 51.13±4.23 | <0.0001 |
| Social functioning | 69.92±5.81 | 50.72±2.83 | <0.0001 |
| Mental health | 54.03±7.35 | 48.48±4.54 | <0.0001 |
| Role limitation due to emotional problems | 49.31±10.41 | 44.56±3.25 | 0.0009 |
| Energy and vitality | 79.74±6.99 | 49.49±5.00 | <0.0001 |
| General perception of health | 55.65±7.85 | 57.05±2.56 | 0.1910 |
| Bodily pain | 70.11±6.76 | 52.58±4.64 | <0.0001 |
| Follow up (week) | 42.29±10.41 | 7.49±4.86 | <0.0001 |
| Dressing week | 2.24±0.70 | 4.10±0.91 | <0.0001 |

**Table 4:** Comparative descriptive analysis of patient outcomes between those with recurrent pilonidal disease and those with persistent wound failure, including statistical significance (*P values*)

| Parameters | Recurrence of pilonidal disease | Persistent wound failure | *P* value |
|---|---|---|---|
| Age | 24.04±4.96 | 27.16±5.49 | 0.0193 |
| Sex (male/female) | 23/1 | 54/1 | |
| Healthcare costs ($) | 1.99±0.28 | 1.66±0.15 | <0.0001 |
| Physical functioning | 53.38±5.11 | 50.11±4.62 | 0.0064 |
| Role limitation due to physical problems | 55.29±5.23 | 51.13±4.23 | 0.0004 |
| Social functioning | 61.58±5.27 | 50.72±2.83 | <0.0001 |
| Mental health | 51.54±5.64 | 48.48±4.54 | 0.0126 |

| | | | |
|---|---|---|---|
| Role limitation due to emotional problems | 50.42±6.38 | 44.56±3.25 | <0.0001 |
| Energy and vitality | 54.42±5.24 | 49.49±5.00 | 0.0002 |
| General perception of health | 59.21±4.08 | 57.05±2.56 | 0.055 |
| Bodily pain | 51.29±2.59 | 52.58±4.64 | 0.2061 |
| Follow up (week) | 14.25±6.05 | 7.49±4.86 | <0.0001 |
| Dressing week | 2.96±0.85 | 4.10±0.91 | <0.0001 |

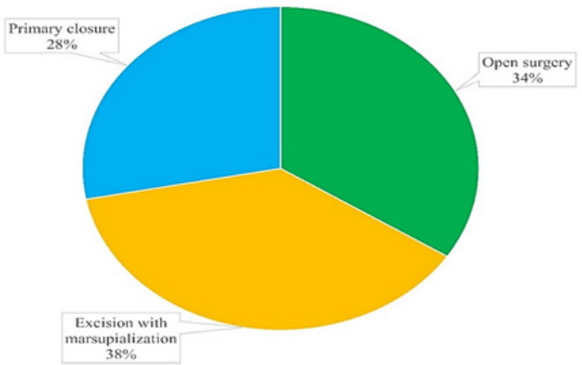


**Fig. 4:** Pie chart showing the distribution of patients undergoing different ways of surgeries.

## DISCUSSION

Patients with PD often experience significant morbidity due to high recurrence rates and the development of persistent sores or fistulas. While not life-threatening, pilonidal sinus can cause pain and a reduced quality of life due to complications such as abscess formation, discharge, or inflammation[8,9]. Although the condition can occur in various areas, such as the axilla, umbilicus, and interdigital space, it most commonly manifests in the sacrococcygeal region between the buttocks[10]. Previous research may not significantly alter our findings, as surgeons have traditionally relied more on "return on recurrence" follow-up rather than routine follow-up[11]. The variety of documented treatment methods underscores the challenges in managing PD, with no single approach universally superior[11]. It is crucial to consider that the follow-up period significantly impacts the recurrence rates of surgical procedures for PD. This reliance is unique to each surgical technique, referring to the rate at which recurrence increases with prolonged follow-up intervals. Applying a recurrence rate without knowing the time since surgery could lead to bias[12].

The most common causes of recurrence include wound infection, abscess formation, or incomplete removal of tracts during the initial operation, which can lead to the formation of new sinus tracts within the cicatrizing wound. Factors such as the accumulation of dead tissue or debris in the intergluteal cleft, perspiration, friction, or inadequate hygiene also contribute to recurrence[13].

There is continuous discussion in the medical literature on the diagnosis and classification of recurrence in PD. The recurrence of symptomatic PD following an initially successful surgical surgery has been generally considered a recurrence. Wound failure experienced by patients as a component of recurrence is frequently included in this description. On the other hand, this method might make it difficult to distinguish between a real recurrence and postoperative wound failure, which could result in inaccurate assessments of the effectiveness of treatment and surgical results.

The misconception that arises from equating recurrence with wound failure might impede the assessment of therapy effectiveness and hinder the advancement of focused management approaches. Postoperative chronic wound failure, which refers to the continuation of symptoms and consequences despite the first surgical intervention, may indicate a unique problem distinct from real disease recurrence. Unlike recurrence, which usually involves the formation of new pits or tracts, wound failure largely arises from poor healing or complications in the wound without the emergence of new disease symptoms.

The literature describes various surgical approaches for treating primary pilonidal sinus, generally categorized into open and closed methods. The open surgical method is straightforward, but while the recurrence rate is low, wound healing and postoperative management are prolonged. Marsupialization, on the other hand, accelerates healing by shallowing the cavity after the lay-open approach. Lee *et al*.[1] recommend primary closure for the initial illness and flap repair to prevent recurrences. Opinions on the most effective surgical method for treating primary, persistent, or recurrent PD are not unanimous, leading to varied management approaches. Nonetheless, the treatment goals are similar: eliminate PD, achieve complete wound healing, and prevent further recurrences[2].

In a study comparing primary closure and Limberg flap reconstruction, Duman *et al*. found that patients in the Limberg flap group had better mental health and less bodily pain compared to the primary closure group. However, both groups experienced anxiety and depression, with more severe symptoms in the primary closure group. The study also noted that Limberg flap patients could walk without pain sooner, indicating better quality of health outcomes[1]. Ertan *et al*.[14] also

reported higher scores for general health perceptions, bodily pain, and social functioning in the Limberg flap group compared to primary closure for pilonidal sinus treatment.

When comparing scores between patients with complete wound healing and those with recurrent disease, it was observed that the recurrent group had lower scores in physical functioning, role limitation due to physical problems, social functioning, and energy and vitality. Similarly, patients with complete wound healing had higher scores across all parameters compared to those with persistent wound failure. However, patients with recurrent disease had higher scores than those with persistent wound failure in most categories. All scores and results of the descriptive analysis were statistically tested.

Francisco Sérgio Rega das emphasizes the significant challenges in managing persistent PD following unsuccessful surgical interventions[15]. Patients with unhealed wounds postprimary treatment and persistent or recurring symptoms often feel discouraged and frustrated with their outcomes. The introduction of appropriate time-to-event analysis to evaluate treatment success is critical, alongside clearly defining parameters like wound healing time and recurrence data. Notably, the recurrence rate of PD is influenced by factors such as operation type, follow-up duration, and geographical considerations. Distinguishing between persistent disease and true recurrence is essential to avoid overestimating surgical success rates. Surgeons must carefully consider disease characteristics and patient-related factors when determining the most suitable surgical approach for each case. Recurrence rates vary, with studies reporting rates from 4% at 24 months to 20% after 60 months, highlighting the variability in outcomes. Meta-analyses emphasize the impact of different surgical techniques on recurrence rates, advocating for tailored approaches to optimize patient outcomes. Geographical variations and the influence of surgical techniques on recurrence rates further underscore the complexity of managing persistent PD[16].

Differentiating between true recurrence and persistent wound failure is crucial in PD management to avoid overestimating surgical success rates and ensure accurate treatment assessment. The true incidence of recurrence and persistent wound failure is challenging to ascertain due to the lack of standardized definitions and clear case reporting in clinical studies[17]. Wound failure in PD can result from various factors, including inadequate wound care, preexisting risk factors (e.g. smoking), and underlying conditions like suppurative hidradenitis or inflammatory bowel disease. The choice of surgical procedure, whether primary closure, flap reconstruction, or secondary healing, also affects the risk of wound failure[17].

After the surgical procedure comparison analysis, it was seen that more than 80% of patients made a full recovery, with very few incidences of wound failure and recurrence. Prospects show that less invasive endoscopic techniques have been developed for more targeted treatment of pilonidal sinus due to the high rates of morbidity and recurrence associated with traditional invasive surgical treatments. These treatments seek to lessen postsurgical morbidity while successfully eliminating factors that contribute to the illness process. In 2014, the first reports of the magnified view of the tracts provided by Video-Assisted Ablation of Pilonidal Sinus (VAAPS) and Endoscopic Pilonidal Sinus Therapy (EPSiT) were published[18].

The study's retrospective design and possible biases in the data gathering are among its limitations. Further prospective research is required to confirm these results and investigate other variables influencing outcomes.

## CONCLUSION

The study concludes that recurrence and persistent wound failure in PD should be regarded as distinct entities due to their differing underlying causes and the unique management strategies they require. Differentiating between these outcomes allows clinicians to more accurately assess true recurrence rates and refine postoperative care. Recognizing the separate causes of recurrence and wound failure facilitates the development of more targeted therapies, leading to improved patient outcomes and reduced complications. This distinction also enables better postoperative management, as persistent wound failure can be treated with interventions focused on wound healing, while true recurrence demands more aggressive approaches to eliminate new sinus formations. Importantly, our study also helps to estimate the true recurrence ratio and, most significantly, aids in patient counseling by clarifying the specific nature of wound failure rather than recurrence, which typically carries a heavier burden for both the surgeon and the patient.

## CONFLICT OF INTEREST

There are no conflicts of interest.

## REFERENCES

1. Lee PJ, Raniga S, Biyani DK, Watson AJ, Faragher IG, Frizelle FA. Sacrococcygeal pilonidal disease. Colorectal Dis. 2008 Sep;10(7):639-50; discussion 651-2. doi: 10.1111/j.1463-1318.2008.01509.x. Epub 2008 Mar 29. PMID: 18384421.

2. Johnson EK, Vogel JD, Cowan ML, Feingold DL, Steele SR; Clinical Practice Guidelines Committee

of the American Society of Colon and Rectal Surgeons. The American Society of Colon and Rectal Surgeons' Clinical Practice Guidelines for the Management of Pilonidal Disease. Dis Colon Rectum. 2019 Feb;62(2):146-157. doi: 10.1097/DCR.0000000000001237. PMID: 30640830.

3. Sondenaa K, Andersen E, Nesvik I, Soreide JA. Patient characteristics and symptoms in chronic pilonidal sinus disease. Int J Colorectal Dis 1995; 10:39–42.

4. Serour F, Somekh E, Krutman B, Gorenstein A. Excision with primary closure and suction drainage for pilonidal sinus in adolescent patients. Pediatr Surg Int 2002; 18:159–161.

5. Saylam B, Balli DN, Düzgün AP, Ozer MV, Coşkun F. Which surgical procedure offers the best treatment for pilonidal disease? Langenbecks Arch Surg. 2011 Jun;396(5):651-8. doi: 10.1007/s00423-011-0768-9. Epub 2011 Mar 8. PMID: 21384188.

6. Katsoulis IE, Hibberts F, Carapeti EA. Outcome of treatment of primary and recurrent pilonidal sinuses with the Limberg flap. Surgeon 2006; 4:7–10.

7. Bendewald FP, Cima RR. Pilonidal disease. Clin Colon Rectal Surg 2007; 20:86–95.

8. Søndenaa K, Pollard ML. Histology of chronic pilonidal sinus. APMIS 1995; 103:267–272.

9. Lorant T, Ribbe I, Mahteme H, Gustafsson UM, Graf W. Sinus excision and primary closure versus laying open in pilonidal disease: a prospective randomized trial. Dis Colon Rectum 2011; 54:300–305.

10. Williams NS. The anus and anal canal. In Williams NS, Bulstrode CJK, (eds.) Bailey & Love's short practice of surgery. 24th edn. London: Russell RCG, Arnold Publishers; 2004. 1242–1271.

11. Rains AJ. Treatment of pilonidal sinus by excision and primary closure. Br Med J 1959; 2:171–173.

12. Weeks RB, Young GG. Sacrococcygeal cysts – report of 200 cases in an army hospital. Am J Surg 1943; 60:260–263.

13. El-Khadrawy O, Hashish M, Ismail K, Shalaby H. Outcome of the rhomboid flap for recurrent pilonidal disease. World J Surg 2009; 33:1064–1068.

14. Ertan T, Koc M, Gocmen E, Aslar AK, Keskek M, Kilic M. Does technique alter quality of life after pilonidal sinus surgery? Am J Surg. 2005 Sep;190(3):388-92. doi: 10.1016/j.amjsurg.2004.08.068. PMID: 16105524.

15. Duman K, Ozdemir Y, Yucel E, Akin ML. Comparison of depression, anxiety and long-term quality of health in patients with a history of either primary closure or Limberg flap reconstruction for pilonidal sinus. Clinics (Sao Paulo). 2014 Jun;69(6):384-7. doi: 10.6061/clinics/2014(06)03. PMID: 24964301; PMCID: PMC4050323.

16. Regadas FS, Murad-Regadas S. Persistent pilonidal disease: what to do when you fail? Sem Colon Rect Surg 2022; 33:100916.

17. Doll D, Orlik A, Maier K, Kauf P, Schmid M, Diekmann M, *et al*. Impact of geography and surgical approach on recurrence in global pilonidal sinus disease. Sci Rep. 2019 Oct 22;9(1):15111. doi: 10.1038/s41598-019-51159-z. PMID: 31641150; PMCID: PMC6805955.

18. Milone M, Musella M, Di Spiezio Sardo A, Bifulco G, Salvatore G, Sosa Fernandez LM, *et al*. Video-assisted ablation of pilonidal sinus: a new minimally invasive treatment--a pilot study. Surgery. 2014 Mar;155(3):562-6. doi: 10.1016/j.surg.2013.08.021. Epub 2013 Oct 25. PMID: 24300343.