Surgery Open Science 9 (2022) 41–45

Contents lists available at ScienceDirect

Surgery Open Science

journal homepage: https://www.journals.elsevier.com/surgery-open-science

Outcomes and cost of medical and surgical treatments of pilonidal disease: A single institution's 10-year review

Kevin C. Janek, MD [a], Meaghan Kenfield, BA [b], Lisa M. Arkin, MD [c], Lily Stalter, MS [a], Giancarlo Tabaro, BA [b], Charles M. Leys, MD [a], Hau D. Le, MD [a,*]

[a] University of Wisconsin School of Medicine and Public Health, Department of Surgery, 600 Highland Ave, Madison, WI 53792
[b] University of Wisconsin School of Medicine and Public Health, 750 Highland Ave, Madison, WI 53726
[c] University of Wisconsin School of Medicine and Public Health, Department of Dermatology, 1 S Park St, Madison, WI 53715

ARTICLE INFO

Article history:
Received 24 October 2021
Received in revised form 18 March 2022
Accepted 24 March 2022
Available online 20 April 2022

ABSTRACT

Background: Pilonidal disease is a chronic inflammatory skin disorder typically located in the gluteal cleft. Treatment varies from antibiotic therapy to extensive surgical resection and reconstruction; however, complications and recurrence are common. To understand risk factors, outcomes, and costs associated with various treatments, we performed a retrospective chart review of all patients treated for pilonidal disease at a single health care system from 2008 to 2018.

Methods: Patients with an ICD diagnosis code associated with pilonidal disease were identified. Charts were reviewed for demographic, clinical, and cost information related to pilonidal disease encounters. Data were analyzed for risk of recurrence by Cox proportional hazards regression and economic burden by Wilcoxon signed-rank test.

Results: During the study time frame, 513 patients were diagnosed with pilonidal disease. Primary treatment included 108 patients (21%) with wide excision, 167 (32%) with antibiotics alone, 79 (15%) with incision and drainage, and 109 (21%) with incision and drainage plus antibiotics. The rate of recurrence following antibiotic therapy, incision and drainage, or wide excision was 36.7%, 35.9%, and 21.3%, respectively. Sex, body mass index, obesity, or hidradenitis suppurativa was not associated with recurrence; however, smokers who underwent incision and drainage had a higher risk of recurrence ($P < .0001$). The median cost of each primary treatment was $3,093 for excision, $607 for incision and drainage, $281 antibiotics alone, and $686 for incision and drainage plus antibiotics.

Conclusion: Pilonidal disease presents with a high degree of heterogeneity and is often managed primarily with antibiotics, incision and drainage, or surgical excision. Risk of recurrence was less in patients who underwent wide excision; however, these patients had higher overall cost compared to patients that had nonoperative management.

Level of evidence: Level III.

INTRODUCTION

Pilonidal disease is a chronic inflammatory process typically in the gluteal cleft that results in the formation of abscesses, fistulas, and sinus tracts which can produce pain, drainage, and recurrent infections [1]. Pilonidal cysts affect mainly postpubertal adolescents and young adults, affecting 2–3 per 5,000 individuals each year, and are 2.2 times more common in males [2]. Although the exact cause of pilonidal disease is unknown, it is thought that obstruction of hair follicles culminates in collection of debris under the surface of the skin [3]. Symptomatic patients who have abscesses are usually treated with incision and drainage (I&D), whereas antibiotics are reserved for those with cellulitis [4]. Surgical intervention has long been the standard treatment for chronic, persistent, or recurrent disease. Despite the large number of operative techniques, success has been limited by wound-healing complications and high recurrence rates.

Patient characteristics for unfavorable surgical outcomes have been thoroughly investigated; however, they are poorly understood for patients who undergo nonoperative treatments. High body mass index (BMI), prolonged sitting, and dense hair are thought to negatively influence outcomes; however, it has been difficult to predict which patients are most likely to require surgical intervention or recur postoperatively [2,5–7]. The ideal treatment is one that is safe, effective, well-tolerated, and economical and results in a low burden of treatment and good

* Corresponding author at: Department of Surgery, 600 Highland Ave, Madison, WI 53792. Tel.: +1 608-263-9419.
E-mail address: leh@surgery.wisc.edu (H.D. Le).

https://doi.org/10.1016/j.sopen.2022.03.009

cosmesis. There is currently no consensus about which approach is most effective despite large-scale systematic reviews and meta-analyses [8,9].

This retrospective study seeks to understand the overall outcomes associated with medical and surgical treatments provided for pilonidal disease over a 10-year period within a single large academic health care system, including recurrence rates after primary treatment, risk factors associated with recurrence, and cost-effectiveness to help clinicians counsel patients about the course of pilonidal disease after various treatments.

MATERIALS AND METHODS

A retrospective chart review was performed of all patients at the University of Wisconsin with pilonidal disease from December 2008 to December 2018. All study procedures were done in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki). A waiver of informed consent and HIPAA authorization was obtained by the University of Wisconsin Health Sciences Institutional Review Board. A search in the *International Classification of Diseases (ICD)* catalogue for all codes which included "pilonidal" was performed. Potential study subjects were identified by the resulting *ICD-9* or *ICD-10* diagnosis codes (*ICD-9*: 685.1 and 685.0; *ICD-10*: L05.01, L05.02, L05.91, and L05.92). All patients who met ICD criteria were included in chart review; however, patients who were subsequently diagnosed with an alternate diagnosis instead or had a remote history of pilonidal disease without available records were excluded from analysis so that an accurate natural course could be elucidated. The medical record numbers and cost of encounters associated with *ICD* codes were obtained through the Department of Data Analytics at the University of Wisconsin Hospital. Costs used for analysis were the actual charges submitted to the payors. Records were reviewed for demographic information and encounters related to the pilonidal disease in which a medical or surgical intervention was performed. These included clinic appointments, ER visits, inpatient admissions, operations, or office-based procedures. Excisions were done by colorectal, pediatric, and adult general surgeons. Time to event was determined using the following definitions: *disease resolution* was defined as documentation of resolution of symptoms at least 30 days since the most recent intervention, and *disease recurrence* was defined as new symptoms following a disease resolution. Censorship events were either the date that the patient left the medical system if a documented departure, the date of last health care encounter if a significant amount of time elapsed since the patient was last seen (>1 year), or the date the study was initiated. Study data were collected and managed using Research Electronic Data Capture (REDCap) hosted at the University of Wisconsin [10,11].

Data were analyzed using descriptive and survival packages in R [12] and R Studio [13], and figures were made using log-rank comparison of survival curves in GraphPad Prism version 8.3.1 for Mac (GraphPad Software, La Jolla, CA). For univariate analysis, assumptions for analysis of variance were checked and violated, and therefore, nonparametric Kruskal–Wallis test was utilized. χ^2 tests were performed for categorical tests except when a small number of patients required use of Fisher exact test. A Cox proportional hazards model was used to report risk of recurrence by hazard ratio using time to recurrence. Proportional hazard assumptions were checked and were not violated. Cost of all treatments was compared to the cost of all treatments when initial treatment was wide excision using Wilcoxon signed rank test.

RESULTS

Overall, 722 unique patients were identified to have 1 or more encounters related to pilonidal disease within the hospital system during the 10-year study time frame. Of these, 513 (71%) patients presented with primary disease and 29% with a remote history of disease without reliable records available. The average age of patients seen at initial diagnosis was 24 ± 10.2 years, and 63% of the patients were male. The average BMI was 28.3 ± 6.5, 6.4% of patients had diabetes, 25% had routine tobacco use within the last 6 months, and 2.3% had hidradenitis suppurativa.

Of the patients with primary disease ($n = 513$), 21% underwent first treatment with wide excision, 33% received oral antibiotics alone, 15% had I&D alone, and 21% had I&D plus antibiotics. Demographic information related to this information is provided in Table 1. Patients who underwent wide excision are more likely to be male ($P < .001$), have a longer duration of symptoms ($P < .0001$), and have a sinus present ($P < .0001$) (Table 1). Most patients who underwent wide excision healed by secondary intent (65%), 28% had primary closure, and 1% had local tissue rearrangement. Less frequently performed procedures included office-based debridement, OR incision and drainage, and pit-picking procedure. Median follow-up time was 169 weeks for antibiotics alone, 166 weeks for antibiotics + I&D, 128 weeks for I&D alone, and 235 weeks for wide excision.

To evaluate the efficacy of each primary treatment, Kaplan–Meier survival curves were generated for each primary treatment strategy from the time of intervention to the time of their first recurrence (Fig 1). For all patients with recurrence, the mean time to presentation was 81.7 ± 136 weeks and median was 34 weeks. This was dependent on treatment strategy (Mantel–Cox log-rank test, $P = .0004$). Mean and median recurrence following intervention was 107 ± 178 and 34 weeks for wide excision, 85 ± 105 and 32.5 weeks for I&D, 48 ± 56 and 31 weeks for antibiotics alone, and 86 ± 151 and 40 weeks for I&D plus antibiotics.

Risk factors for recurrence were determined by performing univariate analysis of primary treatment, sex, BMI, diabetes, tobacco use, and hidradenitis suppuritiva by Cox proportional hazard model using time to disease recurrence (Table 2). Patients who underwent wide excision had the lowest rate of recurrence of 21.3% vs 35.9% of patients who underwent I&D (hazard ratio [HR] 2.16, 95% confidence interval [CI] 1.24–3.76, $P = .006$), 36.7% with antibiotics alone (HR 2.248, 95% CI 1.39–3.64, $P < .0001$), and 35.4% with I&D plus antibiotics (HR 2.813, 95% CI 1.71–4.63, $P < .0001$). No other factors were significant in all patients. These were repeated for each primary treatment subgroup (Supplementary Tables 1–4). Tobacco use in patients with an I&D was a significant risk factor for recurrence (19/30 smokers vs 9/48 nonsmokers, HR 4.551, 95% CI 2.049–10.11, $P < .0001$), as was the presence of cellulitis at initial diagnosis in patients who underwent I&D plus antibiotics (8/14 with cellulitis vs 41/94 without cellulitis, HR 2.206, 95% CI 1.021–4.764, $P = .044$).

Cost-effectiveness of treatment strategy was determined by comparing the encounter costs in which the treatment was performed, as well as the total cost of all treatments performed during the course of their care considering the fact that some treatments resulted in fewer subsequent interventions. Wide excision was the most expensive treatment modality which incurred a median cost of $3,093 per episode, I&D was $607, antibiotics $281, and I&D plus antibiotics $686 (Table 3). The median cost of all pilonidal-related events per patient was determined for each primary treatment and was $3,238 for wide excision, $823 for I&D, $1,279 for antibiotics alone, and $902 for I&D plus antibiotics. The cost of all treatments for each nonsurgical treatment was significantly less than that of patients treated primarily with wide excision, with *P*values < .0001 for all groups when compared by Wilcoxon signed rank test.

DISCUSSION

We characterized the long-term outcomes of pilonidal disease at a large tertiary health care institution over a 10-year period in both adult and pediatric populations to demonstrate the natural course and costs associated with medical and surgical treatments. Patients who had antibiotics and/or I&D had a higher incidence of acute infectious symptoms, and many resolved. Patients who underwent surgery as

Table 1
Demographics and baseline disease characteristics of patients who presented for primary treatment of pilonidal disease

Variable	*Intervention*				
	Wide excision n = *108*	*Antibiotics* n = *167*	*I&D* n = *79*	*I&D + Abx* n = *109*	P *value*
Age, mean (SD)	25.5 (11.5)	23.0 (10.9)	24.0 (8.5)	24.5 (9.6)	.018*
Sex (male)	87 (80.6%)	93 (55.7%)	44 (55.7%)	66 (60.6%)	<.001†
BMI (mean)	27.8	28.0	30.2	29.8	.004*
Current tobacco use	23 (21%)	28 (16.7%)	30 (38%)	36 (33%)	.001†
Median # of weeks with symptoms before treatment (IQR)	23 (6–52)	1 (1–8)	1 (1–3)	1 (0–1)	<.0001*
Diabetes	6 (5.6%)	9 (5.5%)	6 (7.6%)	10 (9.2%)	.688‡
No insurance	6 (5.6%)	7 (4.1%)	3 (3.8%)	7 (6.4%)	.322‡
Diagnosis at presentation					
Sinus present	40 (37%)	15 (8.9%)	4 (5.1%)	4 (3.7%)	<.0001†
Abscess present	7 (6.5%)	56 (33.5%)	45 (57%)	83 (76%)	<.0001†
Cellulitis present	0 (0%)	26 (15.6%)	0 (0%)	15 (13.8%)	<.0001‡
Mean number of clinic visits per patient (SD)	6.4 (5.7)	6.2 (7.4)	3.7 (4.2)	4.1 (4.5)	<.0001*
Mean number of ER visits per patient (SD)	0.2 (0.6)	0.8 (1.1)	1.3 (1.3)	1.4 (1.1)	<.0001*
Mean number of inpatient hospitalizations per patient (SD)	1.3 (0.8)	0.8 (1.2)	0.49 (0.7)	0.7 (0.8)	<.0001*

IQR, interquartile range (25th–75th percentile).
* Kruskal–Wallis test.
† χ^2 test.
‡ Fisher exact test.

the primary treatment had a lower rate of recurrent symptoms; however, they had higher overall cost compared to patients with pilonidal disease that presented with cellulitis or abscess that was initially managed nonoperatively. The large number of patients and long timeline of surveillance allow for new insights into personal and economic burdens related to the most common pilonidal treatments.

There are limited data on the outcomes and risk factors for recurrence following nonoperative treatments. Furthermore, the current approach to manage symptomatic pilonidal disease is based on surgeon's preference because there is no consensus in treatment algorithm, and educating patients on the effectiveness of these therapies can be challenging. The Kaplan–Meier time to recurrence curve provided in Figure 1 can be used to counsel patients on the likelihood and timeline of recurrence regardless of treatment strategy. In our univariate analysis, factors including sex, obesity, diabetes, tobacco use, and hidradenitis suppurativa were nonsignificant for recurrence among all patients when evaluated by Cox proportional hazard analysis. Wide excision as a primary treatment was associated with a lower rate of recurrence than other nonoperative treatment strategies. However, this treatment is expected to be associated with high morbidity due to wound care and complications. Although obesity has been identified as an independent risk factor for recurrence in some studies, this has been inconsistent among sources [6,14–16]. Recurrent disease following excision in this study was 21.1%, with most recurrences occurring within the first 2 years, similar to pooled studies [9,17]. Patients who had an I&D had a higher rate of tobacco use (35% vs 18%), and smokers who underwent I&D were more likely to have recurrent disease (HR 4.551, 95% CI 2.049–10.11). The reason for this is unclear, although smoking is known to impair wound healing, and there is evidence for increased risk of recurrence in smokers with less invasive treatment [18]. This could suggest that smokers who present with an abscess related to pilonidal disease may benefit from smoking cessation, in addition to the likely benefits on wound healing and risk reduction following surgery if needed. Also, patients that underwent I&D plus antibiotics with cellulitis at initial presentation had a higher recurrence rate (HR 2.206, 95% CI 1.021–4.764, $P = .044$). This may be due to the greater disease severity of patients that had clear evidence of cellulitis compared with patients that may have been provided with antibiotics after drainage of a predominant abscess.

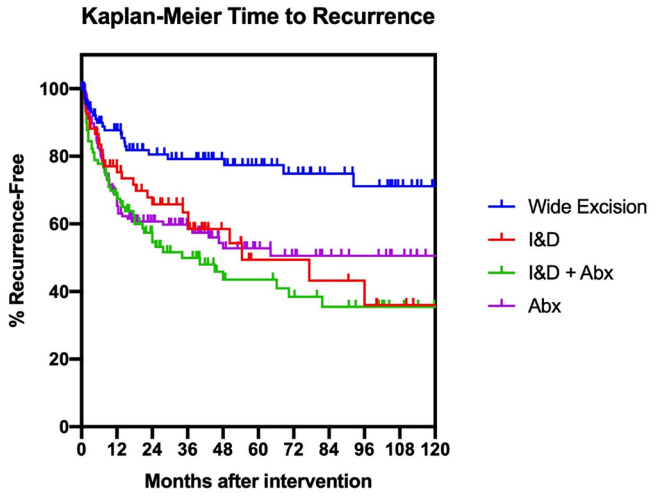

Fig 1. Recurrence-free time period after treatment of antibiotics alone, incision and drainage plus antibiotics, incision and drainage alone, or wide excision. Censorship points were selected if it was the last visit of a patient who transferred care outside of the institution or the duration since diagnosis if they were in health care maintenance for this or other conditions. All remaining events at 120 months were censored due to the time limits of the study. Mantel–Cox log-rank test, $P = .0004$.

Table 2
Unadjusted hazard ratios for risk factors associated with time to recurrence of pilonidal disease.

Risk factor	*Number that recurred*	*Hazard ratio (95% CI)*	P *value*
Primary treatment			
Wide excision	23/108 (21.3%)	–	–
I&D alone	28/78 (35.9%)	2.16 (1.24–3.76)	.006
I&D + Abx	49/108 (35.4%)	2.813 (1.71–4.63)	<.0001
Abx alone	61/166 (36.7%)	2.248 (1.39–3.64)	<.0001
Other	12/50 (24%)	1.510 (0.75–3.04)	.248
Sex			
Male	108/321 (33%)	1.00 (0.73–1.37)	.983
Female	66/192 (34%)	–	–
BMI			
BMI ≥ 30	61/168 (36%)	1.14 (0.83–1.57)	.413
BMI < 30	102/314 (32%)	–	–
Diabetes Status			
Diabetic	13/33 (39%)	0.93 (0.53–1.65)	.809
Nondiabetic	161/480 (33%)	–	–
Tobacco use			
Tobacco use	51/128 (40%)	1.16 (0.83–1.62)	.376
Nonsmoker	123/385 (32%)	–	–
Hidradenitis supp.			
Yes	6/12 (50%)	1.46 (0.65–3.31)	.360
No	168/503 (33%)	–	–

Table 3
Costs of primary treatment and cost of all treatments for those initially treated with wide excision, I&D, antibiotics, or I&D plus antibiotics. Cost of all treatments were compared to the cost of all treatments when initial treatment was wide excision using Wilcoxon signed-rank test.

Primary treatment	*Cost of primary treatment Median (IQR)*	*Cost of all treatments Median (IQR)*	P *value*
Wide excision	$3,093 (2,634–3,811)	$3,238 (2,598–4,100)	–
I&D	$607 (366–847)	$823 (481–1912)	<.0001
Antibiotics	$281 (202–453)	$1,279 (337–3,891)	<.0001
I&D + antibiotics	$686 (424–874)	$902 (427–2,300)	<.0001

It is a general practice to perform a surgical procedure for patients with chronic symptoms or complex disease; however, risk factors for a second episode are less defined. Patients with multiple recurrences are more likely to continue to recur, which have driven investigations into laser hair removal to treat the thick terminal hairs in the gluteal cleft. This has shown some promise to reduce postoperative recurrence rates after wide excision or pit-picking procedures [19–23]. As disease can become more complex with treatment failures, multiple interventions can exponentially increase costs. A wound dehiscence after primary closure, requiring home wound care, and subsequent sacrococcygeal coverage could easily incur costs upwards of $30,000 [24].

Although surgical excision appears to be the most effective primary treatment strategy to minimize recurrence, it does not appear to be the most cost-effective while comparing treatment-associated costs. The median billed cost of surgical excision was $3,093 vs $607 for I&D, $281 for antibiotics, and $686 for I&D plus antibiotics. The difference in cost between nonsurgical treatments could likely be explained by the location of presentation, as most I&Ds are performed in the emergency department or urgent care. The cumulative costs of all encounters for each patient were highly variable. Patients who were initially treated nonsurgically and had recurrence had similar cost to patients who had primary excision; however, due to the large number of patients that did not recur, there was a significant cost savings in the nonsurgical groups. This analysis supports a cost-effective strategy to manage an acute infection with I&D and/or antibiotics and then operate for persistent or recurrent symptoms. Due to the retrospective nature of the study, nonbillable costs were unable to be ascertained, and a true cost analysis would include wound care supplies, lost productivity, and variable health care costs.

Investigations aimed at identifying which patients are most likely to recur following nonsurgical interventions and then reducing risk factors would be highly valuable to reducing the personal and economic burdens of this disease. An example of this would be laser hair removal for patients with risk factors for recurrence and dense hair in the gluteal cleft. We are currently performing a pilot study of laser hair removal as a primary of moderate to severe pilonidal disease to determine if preoperative treatment improves outcomes.

There are several limitations with this study. First, it is a single-institution retrospective cohort study, and the patient population reflects the community served by the hospital system in Madison, WI. The procedures and interventions represent a practice pattern of a limited number of providers, and the study design cannot take into account characteristics that were not documented or were unclear in the patient's medical record. For example, the presence of cellulitis was difficult to characterize retrospectively, and for many patients who were treated with antibiotics, the diagnosis of cellulitis was not clear if they also underwent an I&D. Although the long time frame of this study attempted to capture as many patients with recurrence as possible, the actual follow-up time was variable, and practice patterns may change over a long period of time. Unfortunately, loss to follow-up is a major factor in long-term retrospective studies, including this study. In our experience, patients who are experiencing mild symptoms may forego an intervention, and follow-up with recurrent disease may not equate to resolution and remission of disease. Also, as this disease affects adolescents and young adults, there is a relative infrequency of contact with health care providers, and patients may simply not have had follow-up after a treatment. In this case, it is impossible to know if they moved to another area, saw a provider at a different institution, or have remained symptom-free, resulting in a high rate of censorship in the survival analysis.

Pilonidal disease presents with a high degree of heterogeneity and is often managed primarily with antibiotics, incision and drainage, or surgical excision. Risk of recurrence was less in patients who underwent wide excision; however, they had higher overall cost compared to patients that had nonoperative management.

Supplementary data to this article can be found online at https://doi.org/10.1016/j.sopen.2022.03.009.

Disclosures

Author Contribution. Kevin C. Janek: Conceptualization, Methodology, Analysis, Data curation, Writing – original draft, Funding acquisition. **Meaghan Kenfield**: Investigation, Data curation, Writing – review & editing. **Lisa Arkin**: Conceptualization, Methodology, Writing – review & editing. **Lily Stalter**: Methodology, Formal analysis, Writing – review & editing. **Giancarlo Tabaro**: Investigation, Data curation, Writing – review & editing. **Charles Leys**: Writing – review & editing. **Hau Le**: Conceptualization, Methodology, Writing – review & editing, Supervision.

Conflict of Interest

The authors have no related conflicts of interest to declare.

Funding Source

Salary support for students (MK, GT) was provided by an institutional foundation award from the Herman and Gwendolyn Shapiro Foundation.

Ethics Approval

A waiver of informed consent and HIPAA authorization was obtained by the University of Wisconsin Health Sciences Institutional Review Board (2019-0273).

References

[1] SØNdenaa K, Pollard ML. Histology of chronic pilonidal sinus. APMIS. 1995;103(1–6):267–72.
[2] SØndenaa K, Andersen E, Nesvik I, Søreide JA. Patient characteristics and symptoms in chronic pilonidal sinus disease. Int J Color Dis. 1995;10(1):39–42.
[3] Hyppolito da Silva J. Pilonidal cyst: cause and treatment. Dis Colon Rectum. 2000;43(8):1146–56.
[4] Khanna A, Rombeau J. Pilonidal disease. Clin Colon Rectal Surg. 2011;24(01):046–53.
[5] Akıncı Faruk, Mikda Ö. Incidence and aetiological factors in pilonidal sinus among Turkish soldiers. Eur J Surg. 1999;165(4):339–42.
[6] Halleran DR, Lopez JJ, Lawrence AE, Sebastião YV, Fischer BA, Cooper JN, et al. Recurrence of pilonidal disease: our best is not good enough. J Surg Res. 2018;232:430–6.
[7] Doll D, Bosche FD, Stauffer VK, Sinicina I, Hoffmann S, van der Zypen D, et al. Strength of occipital hair as an explanation for pilonidal sinus disease caused by intruding hair: diseases of the colon & rectum. 2017;60(9):979–86.
[8] Grabowski J, Oyetunji TA, Goldin AB, Baird R, Gosain A, Lal DR, et al. The management of pilonidal disease: a systematic review. J Pediatr Surg. 2019;54(11):2210–21. S0022346819302027.
[9] Obolenskiy VN. Surgical approach choice and efficiency of complementary therapies in treatment of pilonidal cyst: meta-analysis and treatment algorithm. Wound Medicine. 2017;19:39–46.
[10] Harris PA, Taylor R, Minor BL, Elliott V, Fernandez M, O'Neal L, et al. The REDCap consortium: building an international community of software platform partners. J Biomed Inform. 2019;95:103208.
[11] Harris PA, Taylor R, Thielke R, Payne J, Gonzalez N, Conde JG. Research electronic data capture (REDCap)—a metadata-driven methodology and workflow process

for providing translational research informatics support. J Biomed Inform. 2009;42(2):377–81.
[12] Core Team R. R: a language and environment for statistical computing [Internet]. Vienna, Austria: R Foundation for Statistical Computing; 2019. Available from. https://www.R-project.org/.
[13] R Studio Team. RStudio: Integrated Development for R. [Internet]. Boston, MA: R Studio, Inc. Available from:. http://www.rstudio.com/; 2016.
[14] Arda İS, Güney LH, Sevmiş Ş, Hiçsönmez A. High body mass index as a possible risk factor for pilonidal sinus disease in adolescents. World J Surg. 2005;29(4):469–71.
[15] ÇubukÇu A, Gönüllü NN, Paksoy M, Alponat A, Kuru M, Özbay O. The role of obesity on the recurrence of pilonidal sinus disease in patients, who were treated by excision and Limberg flap transposition. Int J Color Dis. 2000;15(3):173–5.
[16] Keshvari A, Keramati MR, Fazeli MS, Kazemeini A, Nouritaromlou MK. Risk factors for complications and recurrence after the Karydakis flap. J Surg Res. 2016;204(1):55–60.
[17] Stauffer VK, Luedi MM, Kauf P, Schmid M, Diekmann M, Wieferich K, et al. Common surgical procedures in pilonidal sinus disease: a meta-analysis, merged data analysis, and comprehensive study on recurrence. Sci Rep. 2018;8(1):3058.
[18] Iesalnieks I, Deimel S, Zülke C, Schlitt HJ. Smoking increases the risk of pre- and postoperative complications in patients with pilonidal disease: smoking increases the risk pilonidal disease. JDDG: J Dtsch Dermatol Ges. 2013;11(10):1001–5.
[19] Badawy E, Kanawati M. Effect of hair removal by Nd:YAG laser on the recurrence of pilonidal sinus. J Eur Acad Dermatol Venereol. 2009;23(8):883–6.
[20] Halleran DR, Onwuka AJ, Lawrence AE, Fischer BC, Deans KJ, Minneci PC. Laser hair depilation in the treatment of pilonidal disease: a systematic review. Surg Infect. 2018;19(6):566–72.
[21] Khan MAA, Javed AA, Govindan KS, Rafiq S, Thomas K, Baker L, et al. Control of hair growth using long-pulsed alexandrite laser is an efficient and cost effective therapy for patients suffering from recurrent pilonidal disease. Lasers Med Sci. 2016;31(5):857–62.
[22] Oram Y, Kahraman F, KARINCAOĞLU Y, Koyuncu E. Evaluation of 60 patients with pilonidal sinus treated with laser epilation after surgery. Dermatol Surg. 2010;36(1):88–91.
[23] Lukish JR, Kindelan T, Marmon LM, Pennington M, Norwood C. Laser epilation is a safe and effective therapy for teenagers with pilonidal disease. J Pediatr Surg. 2009;44(1):282–5.
[24] Surgical Costs. [Internet]. Pilonidal Support Alliance. [cited 2020 Mar 3]. Available from:. https://www.pilonidal.org/treatments/surgical-costs/.