



Trends toward a tailored approach for pilonidal sinus disease

Classification, staging, and treatment algorithms

Introduction

Pilonidal sinus disease (PSD), usually localized to the intergluteal region, varies from a single pit to extensive sinus formation. The incidence is quoted as 26 per 100,000 with a mean age at presentation of 20 years [1]. It is an acquired disease, with familial predisposition, caused by loose hairs penetrating the skin at the base of the natal cleft resulting in the familiar midline opening (pit or sinus). Hair accumulates forming a cavity, previously called a cyst. Owing to its scales, hair has the propensity to self-exit via a lateral or secondary opening, which consists of raised granulation tissue. The disease causes significant morbidity with multiple episodes of purulent drainage and abscess formation. Many patients seek medical care after prolonged symptoms. Karydakis [2] and Bascom [3] proposed differing theoretical etiological mechanisms but ultimately similar operations.

Natural history

While understanding and management of the condition varies between clinicians, loose hair remains the root of the problem. Using a triple approach (axial hair strength, Bayesian calculation, and criminal morphologic evaluation), Doll et al. concluded that occipital hair (either alone or in combination with hair from other

sites) is responsible for the disease [4]. Bosche et al. showed that patients with pilonidal disease, compared with controls, had stiffer hair (occipital, lumbar, buttock) but the number of midline sinuses was not related to hair stiffness [5]. In one study using electron microscopy, 72% of hairs were found to be rootless [6] while in another, 88% of hairs were orientated with their root end into the sinus [7]. Longitudinal studies demonstrating the natural history of the morphology of the disease are lacking; however, in one study, symptom duration was not related to the number of midline openings [8].

Treatment

There is no consensus on optimal curative surgical treatment—hundreds of operations and modifications have been described. Recurrence rates vary widely from 1% [9] to 95% [10]. Such variability is likely due to patient factors, morphological type of disease, definition of recurrence, method of treatment, surgical technique, and (importantly) follow-up period. Most surgeons thus choose to individualize treatment [11]; however, this is an evidence-free zone. In this article, we aim to address one reason possibly responsible for this variability: morphological types of sacrococcygeal pilonidal sinus disease.

Stauffer et al. [12] found the 5-year recurrence rate after pit/sinus-based surgery to be 16%, while off-midline closure using Bascom cleft lift or Karydakis flap was 2% at the 5-year follow-up (3% at 10 years). The recurrence rate following Limberg/Dufourmentel flaps was intermediate (5% at 5 years and 11% at 10 years).

Classification and staging

Pilonidal sinus disease has not gained surgical prestige as treatment failure is not depressingly common and the condition itself is literally “too close to the anus” [13]. Zinicola asks, “Are we missing something?” [14]. Kuzu points out, “The extent of the disease surely affects the results of the treatment modalities” [15], and Brown states, “[A] formal grading system is necessary ... if any form of comparison is to be carried out” [16].

Several straightforward classification systems have been proposed (see **Table 1**) but none has entered routine clinical use possibly because a relationship with treatment strategies or outcomes has not been evaluated. While clearly the idea of a staging system to guide treatment is not novel, it has recently re-emerged—its development has been published elsewhere [17]. It is unclear whether any categorization will really describe disease severity, indicate

Table 1 Comparison of classification systems

	Quinodoz 1999 [23]	Tezel 2007 [19]	Abdelrazeq 2008 [24]	Awad (points) 2009 [20]	Irkörücü 2011 [22]	Guner 2016 [25]	Karakaş 2017 [21]	Doll 2017 [27]	Berlin 2017
Asymptomatic	1	I	–	–	Ia	–	–	–	–
Abscess	3	II	–	–	–	–	–	–	–
Solitary midline sinus	2	–	Simple	Yes	Ib	I	IA	–	1a
Midline sinuses only	2	–	Simple	Yes	Ib	II	IB	–	2a/2b
Long midline ulcerated wound	–	–	–	–	–	–	–	–	1b
2° sinus in navicular area—unilateral	4	III	Complex	Yes	Ila/Ilb	III	II	LAT	3a
2° sinus in navicular area—bilateral	4	III	Complex	Yes	–	IV	II	LAT	3b
Abscess drainage scar	–	–	–	–	–	–	–	–	3c
2° sinus(es) outside navicular area	4	IV	Complex	–	IV	–	IIIA/IV	LAT	3d
Caudal secondary sinus	4	IV	–	–	–	–	IIIB/IV	P	4a/4b
Recurrent disease	–	V	–	Yes	V	R	V	N	5a–d
Unhealed surgical wound	–	–	–	–	–	–	–	N	5a–d
Hirsute	–	–	–	Yes	–	–	–	–	–
Male	–	–	–	Yes	–	–	–	–	–
Overweight	–	–	–	Yes	–	–	–	–	–
Duration >6 months	–	–	–	Yes	–	–	–	–	–
Size >0.5 cm	–	–	–	Yes	–	–	–	–	–
Length from distal to proximal sinus	–	–	–	–	–	–	–	L	–
Infection	–	–	–	–	–	–	–	0 or 1	–

Roman numerals (I–V) refer to disease types. First author and year of publication are shown. Berlin classification proposed by International Pilonidal Society. Features scoring points in the Awad [20] system are shown

L length, *N* number of definitive surgeries, *P* proximity to the anus, *LAT* lateral openings distance from midline, *R* recurrence

preferred treatment strategy, or predict the early/late success of a particular procedure [17]. In a recent survey, 80% of surgeons (132/165) supported the development and use of a categorization system [18]. Surgeons who routinely perform totally off-midline closure (Bascom cleft lift or Karydakís flap) see no clinical benefit of a classification system, other than for purposes of research.

More than a decade ago, one of the authors (ET) proposed a simple classification for sacrococcygeal pilonidal disease according to the navicular area concept [19]. The navicular area defines the extent of the natal cleft by its lateral edges and an inferior border that represents the posterior border of the anal triangle, as shown in **Fig. 1**. The lateral edges are defined with the patient placed in the jack-knife position as the outer lines of contact are drawn when the buttocks are pushed against each other. The tip of the

coccyx is the apex of the anal triangle and the base of the triangle lies between the ischial tuberosities.

A literature search identified eight classification/scoring systems. Only one is points based [20] with the remainder defining types based on disease appearance. Some are ambiguous [21] where two types may be assigned to the same morphological appearance, e.g., disease tracking from intergluteal sulcus to perianal region could be Type III A or IV.

Symptoms

Three [19, 22, 23] systems take into account the patient's symptoms. Because even extensive disease may be asymptomatic, the presence/absence of symptoms does not affect morphology-based disease staging.

Abscess

Only two systems include an acute abscess as part of the classification [19, 23]. The outcome of an abscess (drained spontaneously or surgically) is a lateral/secondary opening or a healed scar. Either way, abscess formation demonstrates the lateral tracking of the disease that forms part of a different stage. Presence of ongoing symptoms following spontaneous/surgical abscess drainage does not mean the disease is termed "recurrent."

Midline disease

Six systems differentiate patients with only midline disease (no lateral/secondary opening) as being a separate group from those with evidence of lateral tracking [19, 21, 23–26]. Primary (i.e., no previous surgery with definitive intent) midline-only disease may present with

a small dimple (pit), classic sinus opening(s) (hole), or a long open wound.

Lateral openings

Classically, there is a single lateral opening (often with elevated granulation tissue), which is cephalad to the top most midline sinus. Typically, the lateral extension is within 2 cm of midline. Occasionally, the lateral openings are multiple, bilateral, quite distant from the midline, lumbar, or perianal area [17]. Presence of lateral openings is in some way recorded by all classifications [19–25, 27] including four that take into account lateral disease that opens perianally [19, 21, 23, 27].

Recurrent disease

Recurrent disease [19–22, 25, 27] or an unhealed surgical wound [27] is in some way included in the six classifications. It is likely that most patients labeled as having recurrent disease actually have a wound that never completely healed after the initial definitive surgery. Some recurrences represent true de novo midline pilonidal disease with a healed surgical scar.

Patient characteristic such as sex, hirsutism, and weight are included in only one [20] system. These demographic data may be important but would make a classification system too complex. Scoring systems may be impractical.

Berlin 2017 classification

This two-tiered classification is based on the clinical appearance of the disease, as shown in **Table 2**. It was developed after extensive surgical consultation. The five types are mutually exclusive and easy to differentiate clinically. Types 1–4 describe primary disease, i. e., no previous definitive surgery. Type 5 is the broad group classed as “recurrence.” Symptoms and abscess are not included as these may determine management but not morphology. The subtypes are for enthusiasts and time will show their relevance.

Type 1 comprises a single natal cleft opening only; above the tip of the coccyx in a patient with no previous surgery.

Type 2 comprises multiple natal cleft openings only; all completely above the tip of the coccyx in a patient with no previous surgery.

Type 3 comprises midline disease with evidence of superior or lateral extent, all above the tip of the coccyx. Prior abscess drainage is included in this group but not prior definitive surgery.

Type 4 comprises any primary disease below the tip of the coccyx. This includes abscess drainage if it was below the tip of the coccyx but excludes prior definitive surgery.

Type 5 comprises any defect present more than 3 months after definitive surgery.

Definitions of widely used procedures for surgical treatment of PSD

Excision with secondary healing

Secondary healing approaches include leaving the wound open: from the skin edges sometimes down to the sacrococcygeal fascia. The wound is treated by daily dressing changes until healing by secondary intention.

Primary midline closure

Primary wound closure can be accomplished by midline closure techniques, which may minimize tension.

Modified Limberg flap

The modified Limberg flap is a rotational fasciocutaneous rhombic flap that permits primary off-midline closure and flattening of the gluteal cleft. All sinus tracts are resected en bloc down to the deep fascia with a rhombic excision. There is no incision on the lower intergluteal sulcus in the modified Limberg technique [28, 29]. The Dufourmental flap is also a rhombic flap.

Tailored Limberg flap

This is an adaptation of the modified Limberg technique in which the edges of rhombic excision are determined by navicular area boundaries. The flap is

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Trends toward a tailored approach for pilonidal sinus disease. Classification, staging, and treatment algorithms

Abstract

This review article summarizes the approach to patients with pilonidal sinus disease based on morphologically different stages. Pilonidal sinus disease is a very common condition especially among young people. The proposed classifications for pilonidal disease and commonly used procedures are summarized here. There is currently limited literature to justify a particular treatment over another based on disease stage. Off-midline closure has the lowest long-term recurrence rate.

Keywords

Pilonidal disease · Classification · Staging · Treatment · Algorithms

Tendenzen zu einem individualisierten Ansatz bei Pilonidalsinus. Klassifizierung, Stadieneinteilung und Behandlungsalgorithmen

Zusammenfassung

Die vorliegende Übersichtsarbeit bietet die Zusammenfassung eines Therapieansatzes bei Patienten mit Pilonidalsinuserkrankungen auf der Basis morphologisch unterschiedlicher Stadien. Ein Pilonidalsinus ist eine sehr häufige Erkrankung, insbesondere bei jungen Menschen. Die vorgeschlagenen Klassifikationen der Pilonidalsinuserkrankung und die üblicherweise eingesetzten Therapieverfahren werden zusammengefasst. Derzeit gibt es nur begrenzt Literatur, um auf der Basis des Krankheitsstadiums die Bevorzugung einer bestimmten Behandlung gegenüber einer anderen zu rechtfertigen. Die niedrigste Langzeitrezidivrate weist der Verschluss abseits der Mittellinie auf.

Schlüsselwörter

Pilonidalsinuserkrankungen · Klassifikation · Stadieneinteilung · Therapie · Algorithmen

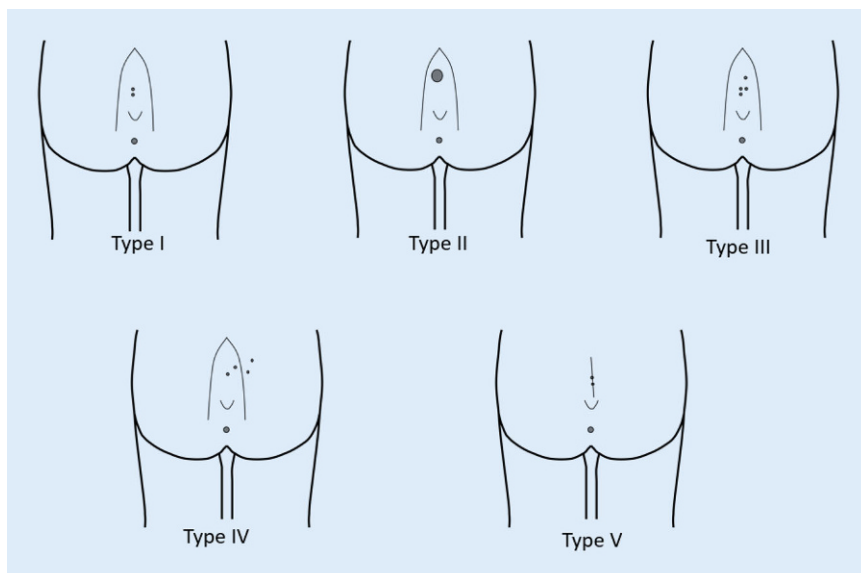


Fig. 1 ▲ Tezel classification

prepared according to the size of resected tissue, i.e., the flap size is equal to the navicular area. It is proposed so as to prevent flaps being too small or too large.

Sinus/pit excision (picking)

Midline pilonidal pits and sinuses are excised by small diamond-shaped incisions or using a punch biopsy needle. The wounds may be closed.

Sinusectomy

This is very similar to sinus/pit excision. Pits and sinuses are excised together with the subcutaneous sinus tract using a scalpel or scissors. Methylene blue marking of the tracks may be used. The excised tissue should be as close as possible to the track. Procedures may be performed blindly or with the use of an endoscope.

Karydakis flap

This technique involves excising the sinus tracks with surrounding tissue using an off-midline elliptical incision. A flap is mobilized from the contralateral side and sutured in multiple layers. The skin is closed off-midline and the natal cleft is flattened [30].

Cleft-lift procedure

This is Bascom's modification of the flap described by Karydakis. The main difference is that only skin containing sinus openings is excised with the cleft lift. A skin flap is mobilized across the navicular area followed by suturing subcutaneous tissue and off-midline skin closure. Any opening in the anal triangle should be included in the excised skin (according to Bascom's original definition; [31, 32]).

Crystallized phenol application

Crystallized phenol is applied into sinus openings after removing hair with the help of a mosquito clamp. As the details remain to be standardized, the surgeon should use the least amount of crystallized phenol possible. In our clinical practice, we apply phenol for 3 min and for a maximum of three times [33].

Treatment algorithms

Asymptomatic disease (Tezel Type 1)

This is a rare presentation of the disease and is often diagnosed incidentally during medical examination for other health problems. These cases mostly consist of a single midline pit or sinus. The absence

of symptoms may prompt the surgeon to recommend nonoperative management. The patient is advised regarding daily showers to prevent the hair from accumulating in the intergluteal sulcus. Regularly removing hair from the area (hair removal cream, laser hair removal) may prevent the disease from becoming active. Shaving is discouraged as it results in sharp hair fragments and a higher disease rate [34]. Doll et al. studied the outcome of surgery in 55 asymptomatic patients and showed that a prophylactic surgery provided no benefit compared with surgery in chronic pilonidal sinus disease [35]. The role of minimally invasive strategies (e.g., pit/sinus excision, crystallized phenol application) remains to be established.

Acute disease including pilonidal abscess (Tezel Type 2)

Acute pilonidal abscess presents with swelling, redness, pain, and warmth in the intergluteal region. This affects activities of daily living, such as sitting and even walking. The pilonidal abscess should be incised, curetted, and the hairs in the cavity removed. Bascom and others advise that pilonidal abscess should be drained through lateral incision [36]. The cavity is left open. Definitive surgery is often performed at a later stage. Antibiotic use after abscess drainage is limited to patients with cellulitis or those who are immunocompromised. First-generation cephalosporin and metronidazole are recommended perioperatively to cover aerobes and anaerobes that are frequently isolated in pilonidal disease [37].

Chronic (symptomatic) disease

Chronic symptomatic disease is defined by one or more sinus openings in the intergluteal cleft, recurrent or permanent swelling, as well as purulent and/or bloody discharge. There are two types of chronic disease according to the Tezel classification: Type 3 represents symptomatic disease with lateral fistula opening(s) limited to the navicular area and Type 4 represents more extensive disease where lateral fistulae are lateral to

Table 2 Berlin 2017 two-tiered classification

Berlin 2017 disease type description		Subtype description	
Type 1	Single midline pit/sinus/wound only (above tip of coccyx; no previous surgery)	1a	Single midline pit/sinus
		1b	Single midline long wound
Type 2	Multiple midline pits/sinuses only (above tip of coccyx; no previous surgery)	2a	Midline sinuses 2 or 3
		2b	Midline sinuses 4 or more
Type 3	Midline plus lateral openings (above tip of coccyx; no previous definitive surgery)	3a	Unilateral lateral extension within navicular area
		3b	Bilateral lateral extension within navicular area
		3c	Abscess scar within navicular area
		3d	Superior/lateral extension beyond navicular area
Type 4	Primary disease extending below tip of coccyx (no previous definitive surgery)	4a	Midline pit(s)/sinus(es)/wound
		4b	Lateral extension
Type 5	Defect after definitive surgery present for more than 3 months	5a	Unhealed wound above tip of coccyx
		5b	Recurrence above tip of coccyx
		5c	Unhealed wound below tip of coccyx
		5d	Recurrence below tip of coccyx

Types 1–5 for clinical use. Subtypes for research purposes

Table 3 Algorithm for treatment of pilonidal sinus disease

Tezel Type	Berlin 2017	Treatment options
Type 1	–	Observe
Type 2	–	Lateral incision + drainage
Type 3	Type 1 Type 2 Type 3	Pit excision or sinusectomy +/- phenol Tailored/modified Limberg flap Cleft lift (Bascom's original description) Cleft lift with pit excision or sinusectomy +/- phenol (for pits in anal triangle) Karydakias flap
–	Type 4	Tailored/modified Limberg flap Cleft lift (Bascom's original description) Cleft lift with pit excision or sinusectomy +/- phenol (for pits in anal triangle) Karydakias flap ± subcutaneous fistulectomy
Type 4	Type 5	Tailored/modified Limberg flap Cleft lift (Bascom's original description) Cleft lift with pit excision or sinusectomy +/- phenol (for pits in anal triangle) Karydakias flap ± subcutaneous fistulectomy
Type 5	–	Phenol only Pit excision only Cleft lift Tailored/modified Limberg flap

the navicular area or in the anal triangle. The proposed Berlin 2017 classification separates chronic disease into four types: Type 1 (solitary midline pit/sinus/wound superior to coccyx tip), Type 2 (multiple midline openings), and Type 3 (midline and lateral openings superior to coccyx tip). Berlin 2017 Type 4 represents any primary disease where there is any extension inferior to the tip of the coccyx.

Pit picking and sinusectomy may be suitable for patients with fewer than four sinuses all located in the midline or within a short distance (e.g., 4 cm) of each other (Berlin Type 1 and 2). The advantages of both procedures are outpatient treatment, quick healing, short recovery period, fast return to work (usually within 3–5 days), and ease of repeatability.

For Berlin Type 3 disease, there are several options of achieving off-midline closure including Bascom cleft lift and Karydakias flap. Depending on flap design, rhombic flaps (Limberg and Duformentel) result in the scar crossing the midline in one or two places, as reviewed elsewhere [38]. Where bilateral lateral openings exist in the navicular area, one option is the modified Limberg flap or the “tailored Limberg flap.”

For Berlin Type 4 disease, there are several treatment options that include Bascom cleft lift, Karydakias flap, either combined with subcutaneous fistulectomy, phenolization with or without cleft lift, or tailored/modified Limberg flap. Phenol treatment for any sinus opening located in the anal triangle has been performed with low complication and recurrence rates [33, 39]. Karydakias proposed that lateral openings some distance from the natal cleft do not need to be excised as hair will self-exit resulting in healing as long as new hairs do not insert by flattening the natal cleft and lateralizing the scar [2].

Recurrent/unhealed disease

Bascom cleft lift, Karydakias flap, and tailored/modified Limberg flap can be performed for Berlin Type 5 disease.

Using background information and expert opinion, a possible treatment al-

gorithm based on the Tezel and Berlin classifications is summarized in [Table 3](#).

Summary

There are several staging systems at hand, ranging from complex to simple in application. The next step is to show whether classifying the different clinical aspects of pilonidal sinus disease does not only keep surgeons busy, but also results in better care for our numerous and young patients.

Conclusion

None of the many classification systems for pilonidal sinus disease is universally used by researchers. The two-tiered Berlin 2017 classification is proposed based on morphological features of the disease, which surgeons find relevant. It is hoped that future publications will require the use of an accepted classification system to determine whether treatment algorithms based on disease severity are relevant.

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Compliance with ethical guidelines

Conflict of interest. E. Tezel, S. Leventoglu, and A. P. Wysocki declare that they have no competing interests.

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References

- Sondenaa K, Andersen E, Nesvik I, Soreide JA (1995) Patient characteristics and symptoms in chronic pilonidal sinus disease. *Int J Colorectal Dis* 10(1):39–42
- Karydakos GE (1992) Easy and successful treatment of pilonidal sinus after explanation of its causative process. *Aust N Z J Surg* 62(5):385–389
- Bascom J (1980) Pilonidal disease: origin from follicles of hairs and results of follicle removal as treatment. *Surgery* 87(5):567–572
- Doll D, Bosche F, Hauser A, Moersdorf P, Sinicina I, Grunwald J et al (2018) The presence of occipital hair in the pilonidal sinus cavity—a triple approach to proof. *Int J Colorectal Dis* 33(5):567–576
- Doll D, Bosche FD, Stauffer VK, Sinicina I, Hoffmann S, van der Zypen D et al (2017) Strength of occipital hair as an explanation for pilonidal sinus disease caused by intruding hair. *Dis Colon Rectum* 60(9):979–986
- Bosche F, Luedi MM, van der Zypen D, Moersdorf P, Krapohl B, Doll D (2018) The hair in the sinus: sharp-ended rootless head hair fragments can be found in large amounts in pilonidal sinus nests. *World J Surg* 42(2):567–573
- Gosselink MP, Jenkins L, Toh JWT, Cvejic M, Kettle E, Boadle RA et al (2017) Scanning electron microscope imaging of pilonidal disease. *Tech Coloproctol* 21(11):905–906
- Doll D, Friederichs J, Dettmann H, Boulesteix AL, Duesel W, Petersen S (2008) Time and rate of sinus formation in pilonidal sinus disease. *Int J Colorectal Dis* 23(4):359–364
- Al-Khamis A, McCallum I, King PM, Bruce J (2010) Healing by primary versus secondary intention after surgical treatment for pilonidal sinus. *Cochrane Database Syst Rev*. <https://doi.org/10.1002/14651858.CD006213.pub3>
- Skobelkin OK, Efendiev AI, Derbenev VA, Ste'anko VG, Dadashev AI (1989) Radical treatment of suppurative pilonidal cysts. *Vestn Khir Im I I Grek* 142(6):123–124
- Murphy S, Wysocki AP (2017) Pilonidal sinus disease surveys. *Pilonidal Sinus J* 3(1):19–27
- Stauffer VK, Luedi MM, Kauf P, Schmid M, Diekmann M, Wieferich K et al (2018) Common surgical procedures in pilonidal sinus disease: a meta-analysis, merged data analysis, and comprehensive study on recurrence. *Sci Rep* 8(1):1–27
- Doll D, Luedi MM, Wieferich K, van der Zypen D, Maak M, Glanemann M (2015) Stop insulting the patient: neither incidence nor recurrence in pilonidal sinus disease is linked to personal hygiene. *Pilonidal Sinus J* 1(1):11–18
- Zinicola R, Cracco N, Serventi A, Martina S, Milone M, Sallustio P et al (2014) Pilonidal sinus: are we missing something? *Colorectal Dis* 16(11):929–930
- Kuzu MA (2008) Commentary. *Colorectal Dis* 10(7):651–652
- Brown SR (2013) Invited comment on Elsej and Lund: fibrin glue in the treatment of pilonidal sinus: high patient satisfaction and rapid return to normal activities. *Tech Coloproctol* 17(1):105–106
- Wysocki AP, Andersson RE, Gips M, Girgin M, Guner A, Immerman S et al (2018) Towards a classification for sacrococcygeal pilonidal disease—Berlin 2017. *Pilonidal Sinus J* 4(1):5–12
- International Pilonidal Society (2018) Survey towards pilonidal classification. <http://www.pilonidal.com.au/blog/item/survey-towards-pilonidal-classification>. Accessed 9 Sept 2018
- Tezel E (2007) A new classification according to navicular area concept for sacrococcygeal pilonidal disease. *Colorectal Dis* 9(6):575–576
- Awad MM, Elbaset AA, Ebraheem S, Tantawy E, Elhafez MA, Elsayed AM (2009) A scoring system as a method to evaluate pilonidal sinus disease to make an easy decision for its management. *Indian J Plast Surg* 42(1):43–48
- Karakas DO, Yilmaz I, Hazer B, Dandin O, Succiullu I (2017) A new approach to classification of pilonidal disease. *Turk J Colorectal Dis* 27:65–66
- Irkörücü OE, Erdem H, Reyhan E (2012) The best therapy for pilonidal disease: which management for which type? *World J Surg* 36:691–692
- Quinodoz PD, Chilcott M, Grolleau JL, Chavoin JP, Costagliola M (1999) Surgical treatment of sacrococcygeal pilonidal sinus disease by excision and skin flaps: the Toulouse experience. *Eur J Surg* 165(11):1061–1065
- Abdelrazeq AS, Rahman M, Botterill ID, Alexander DJ (2008) Short-term and long-term outcomes of the cleft lift procedure in the management of nonacute pilonidal disorders. *Dis Colon Rectum* 51(7):1100–1106
- Guner A, Cekic AB, Boz A, Turkyilmaz S, Kucuktulu U (2016) A proposed staging system for chronic symptomatic pilonidal sinus disease and results in patients treated with stage-based approach. *BMC Surg* 16:18
- Irkörücü O (2016) Management for pilonidal disease: before you compare, use a classification system. *Asian J Surg* 39(4):260–261
- Doll D, Vassiliu P (2018) Another Pilonidal classification—PLLATIN. *Pilonidal Sinus J* 4(1):1–3
- Akin M, Leventoglu S, Menten BB, Bostanci H, Gokbayir H, Kilic K et al (2010) Comparison of the classic Limberg flap and modified Limberg flap in the treatment of pilonidal sinus disease: a retrospective analysis of 416 patients. *Surg Today* 40(8):757–762
- Menten BB, Leventoglu S, Cihan A, Tatlicioglu E, Akin M, Oguz M (2004) Modified Limberg transposition flap for sacrococcygeal pilonidal sinus. *Surg Today* 34(5):419–423
- Wysocki AP (2018) Flaps for pilonidal sinus disease. *Turk Klin J Gen Surg Spec Top* 11(2):124–129
- Bascom J, Bascom T (2007) Utility of the cleft lift procedure in refractory pilonidal disease. *Am J Surg* 193(5):606–609 (discussion 9)
- Tezel E, Bostanci H, Anadol AZ, Kurukahvecioglu O (2009) Cleft lift procedure for sacrococcygeal pilonidal disease. *Dis Colon Rectum* 52(1):135–139
- Yuksel ME (2017) Pilonidal sinus disease can be treated with crystallized phenol using a simple three-step technique. *Acta Dermatovenerol Alp Pannonica Adriat* 26(1):15–17
- Petersen S, Wietelmann K, Evers T, Huser N, Matevossian E, Doll D (2009) Long-term effects of postoperative razor epilation in pilonidal sinus disease. *Dis Colon Rectum* 52(1):131–134
- Doll D, Friederichs J, Boulesteix AL, Dusel W, Fend F, Petersen S (2008) Surgery for asymptomatic pilonidal sinus disease. *Int J Colorectal Dis* 23(9):839–844
- Webb PM, Wysocki AP (2011) Does pilonidal abscess heal quicker with off-midline incision and drainage? *Tech Coloproctol* 15(2):179–183
- Zukiwskyj M, Webb PM (2016) The associated microbiology of pilonidal sinus disease in a small rural hospital. *Pilonidal Sinus J* 2(1):1–4
- Kaplan M, Ozcan O, Bilgic E, Kaplan ET, Kaplan T, Kaplan FC (2017) Distal scar-to-midline distance in pilonidal Limberg flap surgery is a recurrence promoting factor: a multicenter, case-control study. *Am J Surg*. <https://doi.org/10.1016/j.amjsurg.2017.02.008>
- Olmez A, Kayaalp C, Aydin C (2013) Treatment of pilonidal disease by combination of pit excision and phenol application. *Tech Coloproctol* 17(2):201–206