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The current status of surgical pilonidal sinus disease therapy in Germany

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Summary
Purpose Treatment of pilonidal sinus disease (PSD) requires a tailored approach. A national guideline was published in 2014. The current status of surgical PSD therapy in Germany is unknown. The present study aims at evaluating treatment strategies currently used for PSD in Germany. Additionally, changes in surgical practice over the past 20 years were reviewed.
Methods A total of 1191 German hospitals treating patients with PSD were surveyed between September 2015 and September 2016 to identify treatment strategies used for asymptomatic, acute, and chronic PSD. Answers could be provided electronically or by mail. Analysis was performed following irreversible anonymization of the dataset.
Results The return rate of the survey was 38%, with 454 of 1191 hospitals responding. Asymptomatic PSD was treated conservatively by a majority (52%) of participating institutions. Acute PSD was incised, and secondary definitive treatment followed in 42%. Chronic PSD was approached by primary excision and open wound healing in 60% of hospitals, with 33% using a flap technique and 15% an off-midline procedure to close the defect. Over the past 20 years, use of flap procedures and off-midline techniques has increased by 37% and 35%, respectively.
Conclusion The present study reveals that primary excision and open wound healing is still preferred in Germany, in spite of the availability of better options. While the use of flap procedures and off-midline techniques has increased over the past decades, these minimally invasive approaches remained underused, and compliance with the 2014 national guidelines for treatment of PSD remains poor.

Keywords Pilonidal sinus disease · Survey · Germany · Treatment · Therapy

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Introduction

Pilonidal sinus disease (PSD) was first described by Mayo in 1833 [1]. Its national incidence in Norway was reported to be 26/100,000 in 1995 [2]. In Germany, the incidence has increased markedly, reaching 30/100,000 in 2000 and 48/100,000 individuals in 2012 [3]. PSD mostly affects men aged 15–25, with a male-to-female ratio of 2.2:1 to 4:1, with geographic variability [2]. Females represent between 7% and 30% of all patients [4]. The incidence of PSD in the army is higher [5], amounting to 240/100,000 in Germany [4]. While one might suspect this higher incidence to be due to risk factors, it can also be sufficiently explained by the fact that it is primarily young men who are enrolled in military service [4]. A recently published study analyzing 19,000 students between the ages of 17 and 28 years reported an incidence of 6.6%

[6]. Furthermore, the highest incidence rates are reported in the Caucasian population, and the lowest in African and Asian people [7–9].

PSD is supposed to be a disease acquired during puberty, possibly with a genetic predisposition [10–15]. The etiology is multifactorial. Occipital head hair in patients with PSD seems to be stiffer, promoting penetration of healthy skin by cut hair [16–18]. This leads to the development of a fistula, which extends inwards over time, eventually building a hair nest, which increases in size with the addition of more hair. This sinus does not heal spontaneously (asymptomatic type), but can become infected (acute and chronic types) [19]. Risk factors for development of PSD are the thickness of the pre-sacral subcutaneous tissue and the depth of the intergluteal cleft [20–22], but neither obesity nor poor hygiene is a cause [23]. Risk factors for transformation from an asymptomatic type to a chronic or acute type with abscess are thought to be hairy body type, adolescence, and smoking [20, 24].

The clinical presentation depends on the type of PSD. The asymptomatic type, which is defined as the presence of one or more pits in the intergluteal cleft without any symptoms, is diagnosed coincidentally [25]. Although spontaneous healing is not possible, it has been shown that progression of the disease is not the rule [11]. The acute clinical presentation is accompanied by swelling and pain, mostly paramedian of the intergluteal cleft [25], while patients with the chronic type of PSD suffer from an intermittent or continuous discharge [25].

Therapy of PSD depends on its clinical presentation. The asymptomatic type does not require prophylactic surgery [26]. Acute PSD requires an incision and sufficient drainage, which leads to definitive healing in about 60% of patients [25, 27, 28]. A secondary definitive procedure should follow, in order to excise the tracts still in situ. A two-step procedure results in a lower recurrence rate than an attempted single-step surgical cure [29, 30]. Chronic PSD is treated with an elective procedure [25].

To achieve cure, several surgical options are available. These can be classified as minimally invasive procedures (e.g., pit picking), phenol instillation (not allowed in Germany due to toxicity), sinusectomy, lay open, endoscopic procedures, excisional procedures (e.g., excision and open wound healing, excision and midline closure, excision and marsupialization of the wound margins), off-midline procedures with a plastic reconstruction (e.g., Z-plastic, Karydakis procedure, cleft lift procedure, Limberg plastic, V-Y-plastic, Dufourmentel flap), and other procedures such as instillation of fibrin or the transplantation of autologous stem cells [25]. As a consequence of these different treatment options, a portfolio for the optimal treatment of PSD should be created, striving for a short duration of therapy and low rates of complications and recurrence [31, 32]. While the German National PSD Guidelines recommend minimally invasive procedures such as pit picking surgery for limited disease, and off-midline methods for more extensive PSD not suitable for minimally invasive procedures [25], the current status of surgical pilonidal sinus disease therapy in Germany is unknown.

The present study aims to describe current strategies for the treatment of PSD in Germany, evaluating changes in surgical practice over the past 20 years, and report on compliance with the German guidelines published in 2014 [33] for the care of PSD.

Material and methods

Participants

A total of 1191 hospitals treating patients with PSD were identified by screening the German Hospital Directory [34].

Questionnaire

A multicenter survey was conducted using an online platform (soscisurvey.de, SoSci Survey GmbH, Munich, Germany). The survey was sent by email with a link to the head of the surgical department of the queried hospital between September 2015 and September 2016. A reminder email was sent to the non-responders after 1 month.

Questions covered general information about the hospital and the treatment unit for PSD, number of operations and proportion of operations for recurrent disease, expertise of the operating surgeons, treatment strategies for asymptomatic, acute, and chronic PSD, as well as reasons for and against primary excision with open wound healing, plastic reconstructions, and minimally invasive procedures. Additionally, we recorded intra- and postoperative treatment standards, hospital length of stay, and any recommendations for depilation to prevent recurrence.

Statistical analyses

Data were compiled in Excel spreadsheets (Microsoft Office 2016, Microsoft Corporation, Redmond, Washington, USA). Graphics were drawn with GraphPad-Prism 5 (GraphPad Inc., San Diego, CA, USA).

Statistical analysis was performed using Prism (Prism 5; GraphPad Software Inc., La Jolla, USA). Continuous variables were expressed as mean ± standard deviation (SD) or median and interquartile range, as appropriate. Categorical variables are summarized as frequencies (%) and were compared using Pearson's chi-squared test or Fisher's exact test where applicable. P-values < 0.05 were considered to be statistically significant.

Table 1 Frequency of the different treatments for chronic pilonidal sinus disease

	Total	Always	Often	Sometimes	Seldom	Never
Primary open wound healing	404 100%	82 20.3%	199 49.3%	56 13.8%	48 11.9%	19 4.7%
Midline wound closure	402 100%	5 1.2%	21 5.2%	52 13.0%	113 28.1%	211 52.5%
Off-midline wound closure	395 100%	10 2.5%	59 14.9%	69 17.5%	95 24.1%	162 41.0%
Flap techniques	396 100%	3 0.8%	31 7.8%	55 13.9%	153 38.6%	154 38.9%
Minimally invasive treatments	395 100%	5 1.3%	25 6.3%	33 8.4%	48 12.1%	284 71.9%

Results

Response rate, size, and case load of participating hospitals

Of 1191 hospitals contacted in Germany, 454 completed the survey (38.1%). The median number of beds per hospital was 300 (range 13–2000). The median number of operations for PSD per year was 38 (range 3–250). The median share of surgeries for recurrent PSD was 18% (range 0–72%).

The department responsible for surgical treatment of PSD was "general or visceral surgery" in 398/454 hospitals (87.7%), "plastic surgery" in 2/454 hospitals (0.4%), and "others" (pediatric surgery, proctosurgery) in 22/454 hospitals (4.9%). No data were available for 32/454 hospitals (7.0%).

During the day, surgery was performed by residents in 253/454 hospitals (55.7%), by specialists in 225/454 hospitals (49.6%), by attending surgeons in 231/454 hospitals (50.9%), and by chief surgeons in 158/454 hospitals (34.8%). If the operations were performed as an emergency surgery during the night, the operating surgeon was a resident in 179/454 hospitals (39.4%), a specialist in 182/454 hospitals (40.1%), an attending in 252/454 hospitals (55.5%), and a chief surgeon in 69/454 hospitals (15.2%). An affiliated surgeon performed surgeries for PSD in 53/454 hospitals (11.7%) during the day and in 8/454 hospitals (1.8%) during the night.

Treatment of asymptomatic PSD

Asymptomatic PSD was treated conservatively in 236/454 hospitals (52.0%) and operated on in 201/454 (44.3%). No data were available for 17/454 hospitals (3.7%). Shaving of the intergluteal cleft was recommended by 31/437 (7.1%) physicians and laser depilation by 26/437 (6.0%).

Treatment of acute PSD

A majority of hospitals (60.8%; 276/454) favored emergency surgery with full excision. An incision was performed as a single treatment by 63/454 hospitals (13.9%), whereas a two-step treatment concept with a second procedure following an incision was preferred by 192/454 (42.3%).

The preferred surgical procedure was excision with primary open wound healing for 271/454 (59.7%) of the hospitals, and midline closure for 44/454 (9.7%).

Treatment of chronic PSD

Primary open wound healing was used for the treatment of chronic PSD in 69.6% "always" or "often," as outlined in Table 1. The second most frequent surgical procedure was an off-midline closure in 17.4% ("always" or "often"). A wound closure with tissue flaps was routinely performed in 8.6%. Minimally invasive treatment of chronic PSD was the preferred treatment ("always" or "often") in 7.6%. A midline closure was "never" or "seldom" performed in 80.6%. Additionally, we analyzed the correlation between the number of beds in the hospital and the frequency of a primary midline closure. Thirteen percent of hospitals with fewer than 100 beds reported using primary midline closure "often" or "always." In hospitals with 100–500 beds, this frequency decreased to 6–7%, while primary midline closure was almost never performed in hospitals with more than 500 beds (1%).

In case of primary open surgery, an excision alone is performed by 89.4% (378/423) of the queried hospitals, marsupialization by 6.4% (27/423), and other procedures by 4.2% (18/423). If closures are performed, then the preferred surgical procedure for an off-midline closure is the Karydakis procedure in 72.6% (201/277), followed by a Bascom procedure in 14.8% (41/277). In 85.5% (242/283) the Limberg flap is the standard procedure for wound closure, whereas in 86/283 (30.4%), the modified Limberg flap is used. In the 153 hospitals reporting use of a minimally invasive technique, the technique used most often by 97 hospitals (63.4%) was a pit-picking procedure. In addition, in 34 hospitals (22.2%) a sinusectomy was performed.

The etiology of pilonidal sinus

Furthermore, we asked about factors contributing to the etiology and recurrence of PSD. Answers included obesity (65.3%, 261/400), stiff hair (53.5%, 214/400), male sex (51.3%, 205/400), recurrent folliculitis (48.3%, 193/400), profuse sweating (42.3%, 169/400), familial predisposition (40%; 160/400), a deep intergluteal fold (30%, 120/400), and poor personal hygiene (26.5%, 106/400). Additional factors mentioned were a seated activity, smoking, race, embryological factors, and hormonal disturbances.

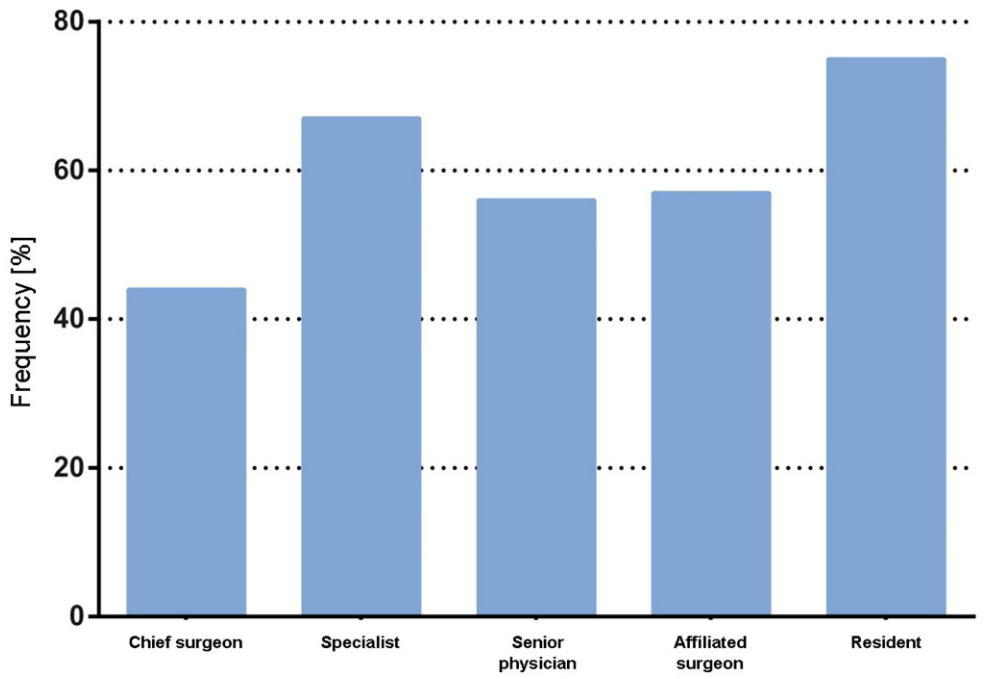

Fig. 1 Frequency of the primary open wound healing technique, correlated with experience of the operating surgeon

Choice of procedures

In the next point we asked about the choice of surgical procedures. Primary open wound healing was chosen by 63.9% (267/418) due to the perceived low recurrence rate, and by 61.0% (255/418) because the operative technique was considered easy to perform. Other arguments given were the short operation time (49.3%, 206/418), a short hospital stay (36.1%, 151/418), and low costs (28.7%, 120/418). Arguments against primary open wound healing were a prolonged healing time (68.6%, 251/366), a longer time off work (8.2%, 30/366), an inferior cosmetic result (10.7%, 39/366), and a high recurrence rate (7.4%, 27/366). Also, patient discomfort was an argument against primary open wound healing for 7.1% (26/366).

The anticipated benefits of a flap technique were a quicker return to work and leisure activities for 49.8% (204/410), a low recurrence rate for 27.1% (111/410), a short hospital stay for 9.8% (40/410), and a low postoperative complication rate for 9.5% (39/410). Flaps on the other hand were deemed to be technically demanding by 50.2% (205/408), have a high postoperative complication rate in 46.1% (188/408), as well as having a long operation time (34.1%, 139/408), a long postoperative hospital stay (24.8%, (101/408), a high recurrence rate (17.5%, 72/408), and high costs (6.9%, 28/408).

An evaluation of the experience of the operating surgeon showed that 75% of younger residents operating on chronic PSD "always" or "often" used an excision and primary open wound approach. When specialist surgeons operated, the rate of excision with primary open wound healing for chronic PSD decreased to 67%, then to 56% for affiliated surgeons, and to 44% when chief surgeons operated (Fig. 1).

A flap repair is chosen by 6% of residents, 10% of specialists, 16% of senior physicians, and 11% of affiliated surgeons. Eleven percent of chief surgeons perform a flap repair (Fig. 2).

Changes in treatment strategy over the past 20 years

That there had been a change in the treatment of PSD over the past 20 years was confirmed by 39.5% of hospitals (179/454) and denied by 38.5% (174/454). No data were available from 101/454 hospitals (22%). The changes are shown in Table 2.

Perioperative care strategies

There were many different approaches to the use of antibiotics, regardless of the surgical technique used. Half of the responders (49.5%, 200/204) said they routinely give perioperative antibiotics, while 49.5% (200/404) said they do not give any antibiotics at all. Single-shot antibiotic use was reported by 34.9% (141/404), whereas 8.4% (34/404) said they give a 1- to 3-day antibiotic course. Antibiotics were given intravenously in 31.2% of cases (126/404) and orally in 7.4% (30/404). A local antibiotic was used in 1.0% (4/404).

Drainage (of any type) was used in 76.8% (262/341) of primary wound closures.

The average length of the postoperative hospital stay—independent of the type of surgery—is shown in Fig. 3. An outpatient procedure was performed in 11.0%, whereas 72.9% of patients were discharged within 3 days.

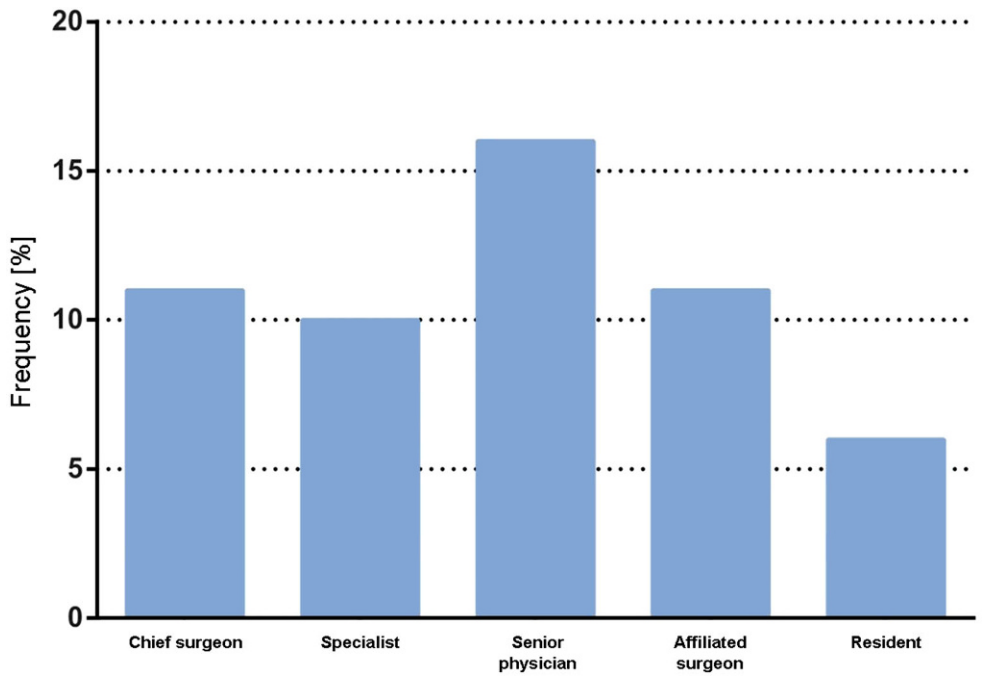

Fig. 2 Frequency of flap techniques correlated with the experience of the operating surgeon

When considering the type of surgery, 85% of the hospitals that used primary open wound healing discharged the patients on the first postoperative day. Moreover, 77% of the hospitals who preferred primary open wound healing performed an outpatient surgery. Hospitals that discharged patients later performed more flap techniques (19% when discharging on postoperative day 4–5, 17% on postoperative day 6–8). Flap surgeries were performed as outpatient procedures in only 3% of chronic PSD patients.

Postoperative depilation to prevent recurrence of PSD was advised in 44.3% (174/393) of the hospitals. If recommended, the method chosen was depilation by shaving in 64.4% (112/174), by laser in 42.0% (73/174), and with a depilation cream in 32.2% (56/174).

Discussion

Which therapy is optimal for the treatment of PSD is a much-debated topic, with conflicting scientific evidence and few high-quality studies to inform the clinician. The present study analyzed the treatment strategies used in Germany. Almost 40% of questionnaires were returned, ensuring that the replies represented actual practice as reported. The median annual number of PSD surgeries performed per hospital in Germany was 38, a level similar to figures previously reported in Austria (median of 30) and Switzerland (median of 50) [35]. Also, the rates of procedures performed to treat recurrent PSD were similar when comparing Germany (18%), Austria (18.2%), and Switzerland (19.7%).

The vast majority of surgeries for PSD were performed in departments of general or visceral surgery (87.7%), with only 0.4% of plastic surgery departments involved in the care of PSD patients in Germany. This may explain the high proportion of open wound approaches (69.6%) and the low share of off-midline closures (17.4%) and flap procedures (8.6%) in Germany. Austria and Switzerland report much lower rates of open wound healing (40% and 36%, respectively). Last, flaps are used by the Swiss in 5% of cases and by the Austrians in 27% [35].

The main reasons that German responders reported opting for excision and primary open wound healing were the low recurrence rate (63.9%) and the easy operative technique (61.0%). However, the recurrence rate after excision and primary open wound closure can be as high as 21% after a follow-up of 4 years [36], with late recurrences reported even up to 22 years after the primary surgery [37]. A recently published meta-analysis of 10,166 patients undergoing primary open treatment reported a recurrence rate of 19.9% at the 10-year follow-up [26]. Notwithstanding the true long-term recurrence rate, primary healing of an open wound following primary excision can take years [25], translating into frequent clinical visits, an increased burden on healthcare systems, and prolonged sick leave.

Indeed, 68.6% of the responders in our study mentioned the long healing time as an argument against a primary open wound healing [38]. The supposition that open wound healing (healing by second intention) yields a stable, hairless scar with low recurrence (folliculitis theory, Bascom theory) has not stood the test of time or science. Conversely, surgical flattening of the natal cleft to prevent insertion of hair from the head appeared more prone to success. Also, primary midline closure is no longer recommended as a treatment for chronic PSD [25] due to recurrence

Table 2 Changes in the treatment of chronic pilonidal sinus disease over the past 20 years

	Rarer (%)	Unchanged (%)	More frequent (%)
Primary open wound healing	39	35	8
Midline closure	38	25	13
Off-midline closure	22	19	35
Flap techniques	16	21	37

in up to 42% of patients [36, 39, 40]. Indeed, high recurrence rates in this setting have been observed for decades [31–44]. Moreover, wound infections and wound dehiscences occur significantly more often after a midline closure than after an off-midline closure [45]. Despite these facts, 19.4% of the participants in our study reported using a midline closure "sometimes," "often," or "always," and 13% more frequently than 20 years ago.

Regarding the frequency with which flap techniques are used, we found a 37% increase over the past 20 years, with 85.5% of the participating hospitals reporting the use of either a classical or a modified Limberg flap as the standard flap technique. The key benefits cited for flap techniques are the fast return to work and leisure activities (49.8%), a low recurrence rate (27.1%), a short hospital stay (9.8%), and a low postoperative complication rate (9.5%). Postoperative care also consumes far fewer resources than open wound healing [46]. Arguments against flap techniques were the fact that they are technically demanding (5%), the high postoperative complication rate (46.1%), a long postoperative hospital stay (24.8%), and the high recurrence rate (17.5%). Importantly, the claim that flap techniques are associated with high recurrence rates is contradicted by several publications reporting a recurrence rate of 0–5% after a modified Limberg flap [47–51]. A recent large study published in 2018 analyzed 12,384 patients following Limberg or Dufourmentel flap techniques and found a recurrence rate of 11.4% after a follow-up of 10 years [28]. Hence, flap techniques show a significantly lower recurrence rate when compared to primary open wound closure. Learning to perform flap techniques is also easier than feared by some of the participating surgeons in the present study [28].

For off-midline closures, 72.6% of responders named the Karydakis procedure as the preferred surgical procedure, followed by a Bascom procedure (14.8%). For both procedures a large meta-analysis found a recurrence rate of 2.7% after a follow-up of 10 years [28]. A study from 2013 found advantages for the Karydakis procedures with regard to duration of the operation, wound infections, and patient satisfaction in comparison to the Limberg flap [52]. Moreover, in 2007 the Karydakis procedure was even recommended for infected tissue due to its low complication rates [53]. The significant benefits of off-midline procedures in comparison to midline closure are the shortest scar tissue crossing the midline and the tension-free wound closure [41, 54].

The lengthier hospital stay for a flap technique—which traditionally lasts 3 to 5 days [48, 49, 55, 56]—was seen as a drawback of these procedures by 24.8% [46]. However, primary wound healing essentially transfers the burden of care to the outpatient setting, with a healing time of months being the rule [25]. Hence, from the perspective of the patient and society, open wound healing represents a net and important loss of resources, and is associated with low patient satisfaction, also due to the higher recurrence rate reported after open wound healing [57].

A longer operation time was also seen by 34.1% as a drawback of flap techniques, which—depending on clinical complexity and surgical technique—varies between 15 and 53 min for an excision with primary open wound healing [58–60] to 49–89 min for the Limberg flap [56, 58, 61]. These longer operation times are also reflected in higher hospital costs, which was considered by 6.9% to be an argument against flap techniques. Given that most PSD patients are young and healthy and don't require extensive resources perioperatively, the negative economic impact of prolonged surgery might be overestimated [62, 63].

The midline closure technique, which is used in 6.4% of the hospitals is Germany, is clearly rejected by the German guidelines [25]. Interestingly, a survey from 2010 analyzing 129 hospitals found that this procedure was used in 70% of Danish hospitals [64]. A similar study with results from 56 Australian hospitals showed totally different results. The most frequently used surgical technique (38%) in Australia was an asymmetric flap technique, which included the Karydakis procedure. Midline closures were performed in 16%, which is still much more frequently than in Germany. A striking difference between Australia and Germany is the low number of primary excisions with open wound healing in Australia (9% vs. 69.6%). In comparison, the frequency of the excision and open wound healing procedure was 40% in Austria and 36% in Switzerland [35].

In the present study, one fifth of the PSD caseload in German institutions was devoted to recurrent PSD (range 0–72%). The current literature reports recurrence rates of up to 42%, depending on the surgical technique and length of follow-up [32, 34]. The broad range of recurrence procedures reported here may reflect differences in follow-up practice and specialization of tertiary institutions.

In the presence of acute PSD, incision/deroofing followed by a second operation as a definitive treatment was preferred in Germany by 42.3% of responders. In comparison, in Austria and Switzerland the frequency was 67% and 64%, respectively [35]. Although this approach is supported by recent literature [29], an excision with primary open wound healing was the preferred treatment for 59.7% of the queried surgeons. In 2017, Petersen et al. proposed a further

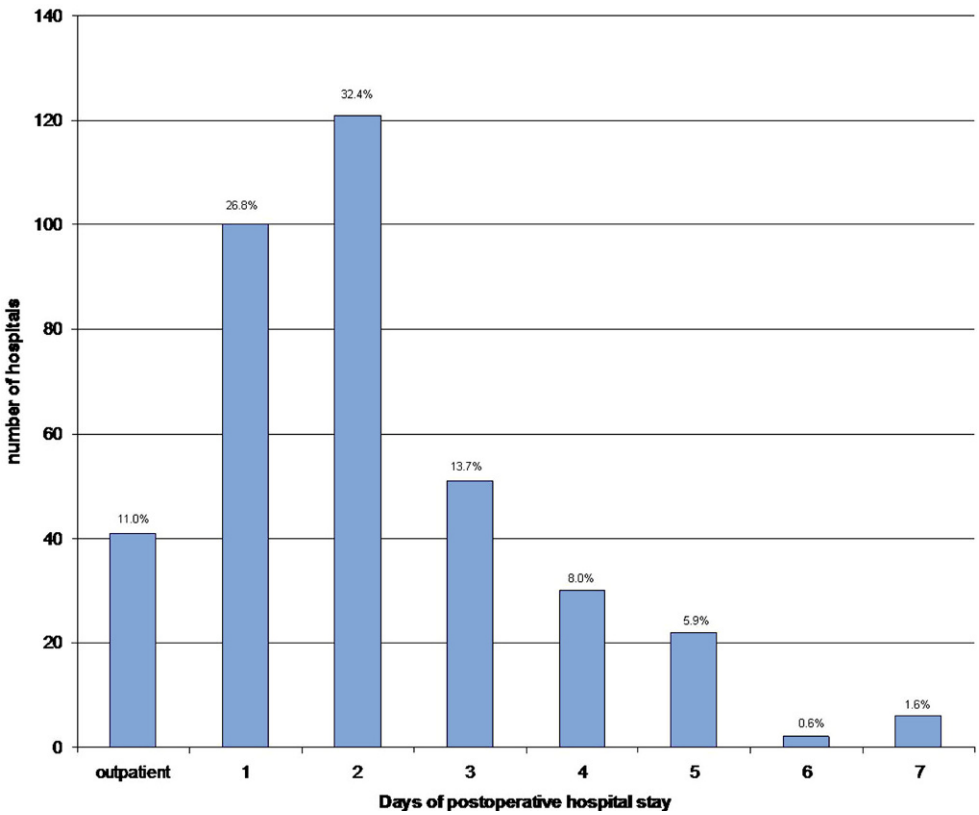

Fig. 3 Length of postoperative hospital stay in days, independent of the type of surgery

approach, reporting that a primary Karydakis procedure could be performed in the acute setting with low complication and recurrence rates in the short-term [53].

Asymptomatic PSD was treated conservatively by 52% of German responders filling out the survey, and operated on by 44.3%. Interestingly, Doll et al. reported as early as 2008 that prophylactic surgery for asymptomatic PSD has no advantages in comparison to operation of chronic PSD [65]. Currently, conservative treatment is recommended in the 2014 German guidelines and their 2020 update [25, 33].

Perioperative antibiotics were administered in 49.5% of the German hospitals, independent of the surgical technique performed. However, this topic is still controversial, as some studies advocate antibiotic prophylaxis [66, 67] and other studies do not [68]. Depilation by shaving, which was recommended by 64.4% of the participants in this study, was associated with an increased recurrence rate in a study from 2009 [69]. However, the role of depilation by laser is still debated. Obesity as a relevant factor is mentioned by 65.3%, with some studies claiming that obesity has a negative influence on wound healing and recurrence rates [70, 71].

Our study has several limitations. First and foremost, surveys can be associated with retrospective reporting and selection bias. Voluntary participation and the absence of data monitoring or audit may have biased the present report. On the other hand, a return rate of 38% with 454 institutions participating contributes to a representative picture of the current standard of care for PSD in Germany. Given the qualitative setup of the survey, the obtained data remain of exploratory nature without formal control. However, the results provide important insights into best clinical practice currently observed in Germany.

Conclusion

In summary, the present study reveals current practice in the treatment of PSD in Germany. The preferred surgical procedure for chronic PSD is still excision, followed by primary open wound healing. Today, off-midline closures and flap techniques are performed more frequently than they were 20 years ago. The Limberg flap is the most often used flap technique in Germany due to fast postoperative recovery and a low recurrence rate. Germany is far behind in implementing current evidence in current practice, and compares poorly with other countries in terms of modern PSD therapy. While primary open treatment should be reserved for selected cases, midline closure must be avoided by all means due to the exceptionally high recurrence rate, and flap techniques should be preferred for closing the excisional defect and flattening the midline.

Remarkably, 6 years after publication of a well-acknowledged national guideline on treatment of PSD, adherence to contemporary standards of care remains low. Continued efforts to inform and teach both young and experienced surgeons in the evi-

dence-based approach to PSD will help improve care delivered to patients affected by PSD.

It is hoped that the present study will help relieve common misperceptions and—together with the most recent German guidelines on PSD—contribute to raising the standard of care in Germany [25].

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Conflict of interest R. Schneider, M. Dettmer, N. Peters, T. Lamdark, M. M. Luedi, M. Adamina, and D. Doll declare that they have no competing interests.

References

1. Mayo H. Observations on injuries and diseases of the rectum. London: Burgess & Hill; 1833.
2. Søndenaa K, Andersen E, Nesvik I, et al. Patient characteristics and symptoms in chronic pilonidal sinus disease. Int J Colorectal Dis. 1995;10:39–42.
3. Bundesregierung. 2014. http://www.gbe-bund.de/oowa921-install/servlet/oowa/aw92/dboowasys921.xwdevkit/xwd_init?gbe.isgbetol/xs_start_neu/&p_aid=i&p_aid=90682233&nummer=550&p_sprache=D&p_indsp=-&p_aid=9880488.
4. Doll D, Orlik A, Maier K, et al. Impact of geography and surgical approach on recurrence in global pilonidal sinus disease. Sci Rep. 2019;9:15111.
5. Evers T, Doll D, Matevossian E, et al. Trends in incidence and long-term recurrence rate of pilonidal sinus disease and analysis of associated influencing factors. Zhonghua Wai Ke Za Zhi. 2011;49:799–803.
6. Duman K, Girgin M, Harlak A. Prevalence of sacrococcygeal pilonidal disease in Turkey. Asian J Surg. 2017;40:434–7.
7. Da Silva JH. Pilonidal cyst: cause and treatment. Dis Colon Rectum. 2000;43:1146–56.
8. Chijiwa T, Suganuma T, Takigawa T, et al. Pilonidal sinus in Japan maritime self-defense force at Yokosuka. Mil Med. 2006;171:650–2.
9. Lee HC, Ho YH, Seow CF, et al. Pilonidal disease in Singapore: clinical features and management. Aust N Z J Surg. 2000;70:196–8.
10. Ardelt M, Dennler U, Fahrner R, et al. Puberty is a major factor in pilonidal sinus disease: gender-specific investigations of case number development in Germany from 2007 until 2015. Chirurg. 2017;88:961–7.
11. Doll D, Friederichs J, Dettmann H, et al. Time and rate of sinus formation in pilonidal sinus disease. Int J Colorectal Dis. 2008;23:359–64.
12. Bascom J. Pilonidal disease: origin from follicles of hairs and results of follicle removal as treatment. Surgery. 1980;87:567–72.
13. Doll D, Matevossian E, Wietelmann K, et al. Family history of pilonidal sinus predisposes to earlier onset of disease and a 50 % long-term recurrence rate. Dis Colon Rectum. 2009;52:1610–5.
14. Patey DH. A reappraisal of the acquired theory of sacrococcygeal pilonidal sinus and an assessment of its influence on surgical practice. Br J Surg. 1969;56:463–6.
15. Stelzner F. Die Ursache des Pilonidalsinus und der Pyodermia fistulans sinifica. Langenbecks Arch Chir. 1984;362:105–18.
16. Doll D, Bosche FD, Stauffer VK, et al. Strength of occipital hair as an explanation for pilonidal sinus disease caused by intruding hair. Dis Colon Rectum. 2017;60:979–86.
17. Doll D, Bosche FD, Hauser A, et al. The presence of occipital hair in the pilonidal sinus cavity-a triple approach to proof. Int J Colorectal Dis. 2018;33:567–76.
18. Bosche F, Luedi MM, van der Zypen D, et al. The hair in the sinus: sharp-ended rootless head hair fragments can be found in large amounts in pilonidal sinus nests. World J Surg. 2018;42:567–73.
19. Dahl HD, Henrich MH. Light and scanning electron microscopy study of the pathogenesis of pilonidal sinus and anal fistula. Langenbecks Arch Chir. 1992;377:118–24.
20. Akinci OF, Bozer M, Uzunkoy A, et al. Incidence and aetiological factors in pilonidal sinus among Turkish soldiers. Eur J Surg. 1999;165:339–42.
21. Akinci OF, Kurt M, Terzi A, et al. Natal cleft deeper in patients with pilonidal sinus: implications for choice of surgical procedure. Dis Colon Rectum. 2009;52:1000–2.
22. Doll D, Luedi MM, Wieferich K, et al. Stop insulting the patient: neither incidence nor recurrence of pilonidal sinus disease is linked to personal hygiene. Pilonidal Sinus J. 2015;1:11–8.
23. Sievert H, Evers T, Matevossian E, et al. The influence of lifestyle (smoking and body mass index) on wound healing and long-term recurrence rate in 534 primary pilonidal sinus patients. Int J Colorectal Dis. 2013;28:1555–62.
24. Balik O, Balik AA, Polat KY, et al. The importance of local subcutaneous fat thickness in pilonidal disease. Dis Colon Rectum. 2006;49:1755–7.
25. Ommer A, et al. S3-Leitlinie Sinus pilonidalis. 2020. https://www.awmf.org/uploads/tx_szleitlinien/081-009l_S3_Sinus_pilonidalis_2020-07.PSDf.
26. Doll D, Friederichs J, Dusel W, et al. Surgery for asymptomatic pilonidal sinus disease. Int J Colorectal Dis. 2008;23:839–44.
27. Jensen SL, Harling H. Prognosis after simple incision and drainage for a first-episode acute pilonidal abscess. Br J Surg. 1988;75:60–1.
28. Stauffer VK, Luedi MM, Kauf P, et al. Common surgical procedures in pilonidal sinus disease: a meta-analysis, merged data analysis, and comprehensive study on recurrence. Sci Rep. 2018;8:3058.
29. Doll D, Matevossian E, Hoenemann C, et al. Incision and drainage preceding definite surgery achieves lower 20-year long-term recurrence rate in 583 primary pilonidal sinus surgery patients. J Dtsch Dermatol Ges. 2013;11:60–4.
30. Hussain ZI, Aghahoseini A, Alexander D. Converting emergency pilonidal abscess into an elective procedure. Dis Colon Rectum. 2012;55:640–5.
31. De Parades V, Bouchard D, Janier M, Berger A. Pilonidal sinus disease. J Visc Surg. 2013;150:237–47.
32. Fahrni GT, Vuille-Dit-Bille RN, Leu S, et al. Five-year follow-up and recurrence rates following surgery for acute and chronic pilonidal disease: a survey of 421 cases. Wounds. 2016;28:20–6.
33. Ommer A, Berg E, Breitkopf C, et al. S3-Leitlinie: Sinus pilonidalis. coloproctology. 2014;36:272–322.
34. Deutsches Krankenhausverzeichnis. 2015. www.deutsches-krankenhaus-verzeichnis.de.
35. Lamdark T, Vuille-Dit-Bille RN, Bielicki IN, et al. Treatment strategies for Pilonidal sinus disease in Switzerland and Austria. Medicina. 2020;56:341.
36. Iesalnieks I, Fuerst A, Rentsch M, et al. Primary midline closure after excision of a pilonidal sinus is associated with a high recurrence rate. Chirurg. 2003;74:461–8.

37. Doll D, Krueger CM, Schrank S, et al. Timeline of recurrence after primary and secondary pilonidal sinus surgery. Dis Colon Rectum. 2007;50:1928–34.
38. Doll D, Matevossian E, Luedi MM, et al. Does full wound rupture following median Pilonidal closure Alter long-term recurrence rate? Med Princ Pract. 2015;24:571–7.
39. Petersen S, Koch R, Stelzner S, et al. Primary closure techniques in chronic pilonidal sinus: a survey of the results of different surgical approaches. Dis Colon Rectum. 2002;45:1458–67.
40. Evers T, Doll D. Pilonidalsinus: Hohe chirurgische Rezidivrate. AmbChir. 2009;6:25–8.
41. Al-Khamis A, McCallum I, King PM, et al. Healing by primary versus secondary intention after surgical treatment for pilonidal sinus. Cochrane Database Syst Rev. 2010; https://doi.org/10.1002/14651858.CD006213.pub3.
42. Allen-Mersh TG. Pilonidal sinus: finding the right track for treatment. Br J Surg. 1990;77:123–32.
43. Kronborg O, Christensen K, Zimmermann-Nielsen C. Chronic pilonidal disease: a randomized trial with a complete 3-year follow-up. Br J Surg. 1985;72:p303–p4.
44. Al-Hassan HKF, Francis IM, Neglén P. Primary closure or secondary granulation after excision of pilonidal sinus. Acta Chir Scand. 1990;156:695–9.
45. Enriquez-Navascues JM, Emparanza JI, Alkorta M, et al. Meta-analysis of randomized controlled trials comparing different techniques with primary closure for chronic pilonidal sinus. Tech Coloproctol. 2014;18:863–72.
46. Petersen S. Exzision und Marsupialisation im Vergleich zu Rhomboidexzision mit Limberg-Plastik beim Sinus pilonidalis. coloproctology. 2010;32:189–90.
47. Cihan A, Mentes BB, Tatlicioglu E, et al. Modified Limberg flap reconstruction compares favourably with primary repair for pilonidal sinus surgery. ANZJ Surg. 2004;74:238–42.
48. Urhan MK, Kücükel F, Topgul K, et al. Rhomboid excision and Limberg flap for managing pilonidal sinus: results of 102 cases. Dis Colon Rectum. 2002;45:656–9.
49. Topgül K, Ozdemir E, Kilic K, et al. Long-term results of limberg flap procedure for treatment of pilonidal sinus: a report of 200 cases. Dis Colon Rectum. 2003;46:1545–8.
50. Kapan M, Kapan S, Pekmezci S, et al. Sacrococcygeal pilonidal sinus disease with Limberg flap repair. Tech Coloproctol. 2002;6:27–32.
51. Kaya B, Eris C, Atalay S, et al. Modified Limberg transposition flap in the treatment of pilonidal sinus disease. Tech Coloproctol. 2012;16:55–9.
52. Bessa SS. Comparison of short-term results between the modified Karydakis flap and the modified Limberg flap in the management of pilonidal sinus disease: a randomized controlled study. Dis Colon Rectum. 2013;56:491–8.
53. Petersen S, Aumann G, Kramer A. Short-term results of Karydakis flap for pilonidal sinus disease. Tech Coloproctol. 2007;11:235–40.
54. Guner A, Cekic AB. Pilonidal sinus—challenges and solutions. Open Access Surg. 2015;8:67–71.
55. Ersoy OF, Karaca S, Kayaoglu HA, et al. Comparison of different surgical options in the treatment of pilonidal disease: retrospective analysis of 175 patients. Kaohsiung J Med Sci. 2007;23:67–70.
56. Muzi MG, Milito G, Cadeddu F, et al. Randomized comparison of Limberg flap versus modified primary closure for the treatment of pilonidal disease. Am J Surg. 2010;200:9–14.
57. Doll D, Luedi MM, Evers T, et al. Recurrence-free survival, but not surgical therapy per se, determines 583 patients' long-term satisfaction following primary pilonidal sinus surgery. Int J Colorectal Dis. 2015;30:605–11.
58. Karakayali F, Karagulle E, Karabulut Z, et al. Unroofing and marsupialization vs. rhomboid excision and Limberg flap in pilonidal disease: a prospective, randomized, clinical trial. Dis Colon Rectum. 2009;52:496–502.
59. Gencosmanoglu R, Inceoglu R. Modified lay-open (incision, curettage, partial lateral wall excision and marsupialization) versus total excision with primary closure in the treatment of chronic sacrococcygeal pilonidal sinus: a prospective, randomized clinical trial with a complete two-year follow-up. Int J Colorectal Dis. 2005;20:415–22.
60. Kepenekci I, Demirkan A, Celasin H, et al. Unroofing and curettage for the treatment of acute and chronic pilonidal disease. World J Surg. 2010;34:153–7.
61. Unalp HR, Derici H, Kamer E. Lower recurrence rate for Limberg vs. V-Y flap for pilonidal sinus. Dis Colon Rectum. 2007;50:1436–44.
62. Luedi MM, Kauf P, Mulks L, et al. Implications of patient Age and ASA physical status for operating room management decisions. Anesth Analg. 2016;122:1169–77.
63. Luedi MM, Kauf P, Evers T, et al. Impact of spinal versus general anesthesia on postoperative pain and long term recurrence after surgery for pilonidal disease. J Clin Anesth. 2016;33:236–42.
64. Fabricius R, Petersen LW, Bertelsen CA. Treatment of pilonidal sinuses in Denmark is not optimal. Dan Med Bull. 2010;57:A4200.
65. Doll D, Friederichs J, Boulexteix AL, et al. Surgery for asymptomatic pilonidal sinus disease. Int J Colorectal Dis. 2008;23:839–44.
66. Karip AB, Celik K, Aydin T, et al. Effect of triclosan-coated suture and antibiotic prophylaxis on infection and recurrence after Karydakis flap repair for pilonidal disease: a randomized parallel-arm double-blinded clinical trial. Surg Infect. 2016;17:583–8.
67. Popeskou S, Christoforidis D, Ruffieux C, et al. Wound infection after excision and primary midline closure for pilonidal disease: risk factor analysis to improve patient selection. World J Surg. 2011;35:206–11.
68. Kundes MF, Cetin K, Kement M, et al. Does prophylactic antibiotic reduce surgical site infections after rhomboid excision and Limberg flap for pilonidal disease: a prospective randomized double blind study. Int J Colorectal Dis. 2016;31:1089–91.
69. Petersen S, Wietelmann K, Evers T, et al. Long-term effects of postoperative razor epilation in pilonidal sinus disease. Dis Colon Rectum. 2009;52:131–4.
70. Doll D, Novtny A, Wietelmann K, et al. Factors influencing surgical decisions in chronic pilonidal sinus disease. Eur Surg. 2009;41:60–5.
71. Cubukcu A, Gönüllü NN, Paksoy M, et al. The role of obesity on the recurrence of pilonidal sinus disease in patients, who were treated by excision and Limberg flap transposition. Int J Colorectal Dis. 2000;15:173–5.