Tech Coloproctol (2014) 18:29–37
DOI 10.1007/s10151-013-0982-2

ORIGINAL ARTICLE

Which flap method should be preferred for the treatment of pilonidal sinus? A prospective randomized study

K. Arslan · S. Said Kokcam · H. Koksal · E. Turan · A. Atay · O. Dogru

Received: 8 November 2012 / Accepted: 21 January 2013 / Published online: 21 February 2013

Abstract
Background Although many methods, either surgical or non-surgical, are being used for the treatment of pilonidal sinus disease (PSD), there is still no consensus as to what constitutes the most appropriate method of treatment. The aim of this study was to compare the outcomes of the Limberg flap (LF), modified Limberg flap (MLF), and Karydakis flap (KF) procedures.
Methods A prospective, randomized study was conducted on 295 patients scheduled for surgical treatment for PSD at the General Surgery Clinic of the Konya Training and Research Hospital in January 2009–May 2010. Patients with recurrent disease, an ASA score higher than III, obesity (BMI > 35 kg/m^2), insulin-dependent diabetes, or a drug or alcohol addiction were excluded. The procedures performed were as follows: LF ($n = 96$), MLF ($n = 108$), and KF ($n = 91$).
Results The patients were followed up for a median of 33 months (range 24–41 months). There were more female patients in the LF group. The rate of seroma formation was higher in the KF group (19.8 %) compared to the LF and MLF groups (5.2 and 7.4 %, respectively; $p = 0.027$). The rate of wound dehiscence was higher in the KF group (15.4 %) compared to the LF and MLF groups (2.1 and 3.7 %, respectively; $p < 0.001$) as was the incidence of flap maceration (11 % in the KF vs. 1 % in the LF and 3.7 % in the MLF; $p = 0.004$). The incidence of PSD recurrence was also higher in the KF group (11 %) compared to the LF and MLF groups (6.3 and 1.9 % respectively; $p = 0.027$). In a multivariate analysis, the presence of seroma, hematoma, and wound infection were independent predictors of recurrence.
Conclusions In our study, LF and MLF procedures were associated with a lower recurrence and complication rate compared to KF. However, more randomized studies comparing different reconstruction methods after PSD excision are needed.

Keywords Pilonidal sinus disease · Limber flap · Modified Limberg flap · Karydakis flap

Introduction

Pilonidal sinus disease (PSD) is a fairly common condition associated with significant morbidity. The disease most frequently occurs in the sacrococcygeal region of the body. PSD, which was considered congenital at first but is recently thought to be acquired, is more prevalent among young males and leads to time loss from school or work. The true prevalence of PSD is unknown. All races can develop PSD; however, it is more common in those with dark, stiff, or auburn hair. In a Norwegian study, the incidence of disease was estimated to be 25 per 100,000 [1]. Approximately 70,000 diagnoses are established annually in the United States [2]. Risk factors include male gender, obesity, sedentary lifestyle, occupations requiring

Presented at the XVI. Annual meeting of the European Society of the Surgery—ESS 2012. İstanbul,Turkey, November 22–24, 2012.

K. Arslan · S. Said Kokcam · H. Koksal · E. Turan · A. Atay · O. Dogru
Department of General Surgery, Konya Training and Research Hospital, Konya, Turkey

K. Arslan (✉)
Genel Cerrahi Bolumu, Konya Egitim ve Arastirma Hastanesi, Hacı Şaban Mahallesi Meram, Yeniyol Caddesi No: 97, 42040 Meram, Konya, Turkey
e-mail: arslanka74@hotmail.com

sitting, family history, hirsute body habitus, trauma or irritation to the gluteal cleft skin, and poor hygiene [2–4].

Surgical and non-surgical methods are used for the treatment of the PSD. For the surgical management of chronic PSD, many options ranging widely from simple excision with or without primary closure to complex flap reconstruction are available [2, 3]. There is no consensus yet on a standard surgical method, which has proven to be superior or is widely accepted. To the best of our knowledge, there is no study comparing Limberg flap (LF), modified Limberg flap (MLF), and Karydakis flap (KF) procedures in the literature; thus, we aimed to compare the outcomes of these three surgeries in a prospective randomized study.

Materials and methods

The present prospective randomized study was performed between January 2009 and May 2010 at the General Surgery Clinic of Konya Training and Research Hospital. The study was approved by the Ethics Committee of the Selçuk University Meram Medical Faculty (2009/0038), and written informed consent was obtained from all patients. Patients scheduled for surgical intervention because of PSD were included in the present study. If the patients admitted to our hospital with the diagnosis of sacrococcygeal PSD had abscesses, the abscesses were drained first and the patients were operated on at least 10 days later; those with active infection were operated on after antibiotic treatment.

Exclusion criteria of the study were as follows: recurrent cases, ASA group higher than III, obesity (body mass index >35 kg/m^2), insulin-dependent diabetes, drug and alcohol addiction.

The patients were divided into the following three groups by drawing lots from an envelope: (1) LF group, (2) MLF group, and (3) KF group. For randomization, 120 envelopes were prepared for each group. An envelope designating the surgery type was selected just prior to the operation by the surgical nurse for each patient. The randomization was performed in the outpatient clinic. All patients underwent surgery by or under the supervision of the same surgeon (OD).

To guarantee adequate statistical power, a priori sample size calculation was performed. Because the reported rate of postoperative complications associated with flap procedures varies between 1 and 13 %, it was determined that 112 patients per treatment arm would allow for the detection of a 10 % difference in the rate of complications with 80 % power and 5 % confidence. Eligible patients were randomized to the LF, MLF, or KF repair. Block randomization was done to ensure an equal number of patients assigned to each of the three treatment arms. All patients received inpatient treatment.

Surgical procedures

Prior to the surgical procedure, hair at the surgical site was removed using hair removal cream and 1 g cefazolin sodium was intravenously administered while the patients were on the operating table. The surgical procedure was performed in the jackknife position under spinal anesthesia. A rhomboid excision including the sinus was performed.

Limberg flap surgery was performed as defined in the study by Azab et al. [5]. A rhomboid excision was carried out. A right- or left-sided fasciocutaneous Limberg transposition flap, incorporating the gluteal fascia, was fully mobilized on its inferior edge and transposed medially to fulfill the rhomboid defect. The defect in the gluteal region was closed primarily. The subcutaneous layers were approximated with 2/0 or 3/0 vicryl sutures over a Jackson-Pratt drain, and the skin was closed with 3/0 polypropylene sutures or skin staplers (Fig. 1).

MLF surgery was performed as defined in the study by Menteş et al. [6]. The inferior apices of the rhomboid excisions were extended laterally 2 cm to the inferior midline. The entire sinus tract and diseased area were resected with a rhomboid excision. The flap, incorporating the gluteal fascia, and anatomic bands between the rectum and dermis of the midline sulcus were fully mobilized on the inferior edge and transposed medially to fill the Limberg defect. To remove the midline gap and to transpose the flap to the contralateral side rather than to the midline, the lower pole of the incision was placed on the contralateral side of the elevated flap. In this way, there is no incision on the lower intergluteal sulcus. The subcutaneous layers were approximated with 2/0 or 3/0 vicryl sutures over a Jackson-Pratt drain, and the skin was closed with 3/0 polypropylene sutures or skin staplers (Fig. 2).

Karydakis flap surgery was performed as defined in the study by Karydakis [7]. The technique consisted of a

Fig. 1 Limberg flap repair

Fig. 2 Modified Limberg flap repair

Fig. 3 Karydakis flap repair

vertical eccentric elliptical incision carried down to the postsacral fascia, complete removal of unhealthy tissue with normal tissue around the cyst and sinus tracts, mobilization of the medial wound edge by undercutting the adipose tissue at a depth of 1 cm, the advancement of the flap across the midline to the postsacral fascia and suturing of its edge to the lateral wound edge (Fig. 3). Interrupted 2/0 or 3/0 vicryl sutures were used to fix the flap to the fascia and the skin was closed with skin stapler or polypropylene suture. A Jackson-Pratt drain was placed in all patients.

Drains were not removed until the amount of drainage fluid was less than 20 mL daily. Patients with persistent drainage on day 2 were discharged with their drains. Follow-up visits took place on day 14 and at 1, 3, 6, and 12 months after surgery. In addition, patients were followed up by phone calls at 6-month intervals (minimum 24, maximum 41 months). In addition to demographic characteristics, we evaluated the following: duration of surgery, duration of drainage, length of hospital stay, time until return to work, time until complete healing, development of seroma, hematoma, partial wound dehiscence, wound infection, maceration, hypoesthesia of the surgical area, recurrence, time until recurrence, and follow-up period. The distinction between seroma and infection was made based on the clinical findings and culture results. During the follow-up phone calls, patients who reported complaints of leakage and pain were invited to a follow-up visit, presence of PSD was defined as recurrence.

At the end of the 1-year period, the patients were questioned regarding patient satisfaction (graded as excellent, good, not bad, bad). They were also asked whether they would recommend the surgical procedure which they had undergone to other patients with the same disease. Moreover, characteristics of patients with and without recurrence were compared and factors that cause recurrence were assessed.

Data were analyzed using the Statistical Package for the Social Sciences (SPSS, Inc., Chicago, IL, USA) version 15.0 for Windows program. Descriptive statistics were expressed as cross-tabulations for categorical variables and as mean ± standard deviation or median (minimum–maximum) for continuous variables. The χ^2 test was used to compare independent categorical variables. When the χ^2 condition was not met, the Monte Carlo simulation was used for multiple comparisons and Fisher's exact test was used for the comparison of paired groups. For non-normally distributed continuous variables, the Kruskal–Wallis test was used to compare multiple groups, whereas Bonferroni correction and Mann–Whitney *U* test were used to compare two subgroups. In order to determine the risk factors that cause recurrence, the backward stepwise method and multivariate logistic regression analysis were used. A model was developed including age, duration of surgery, length of hospital stay, duration of drainage, time until return to work, time until complete healing, and follow-up period as continuous variables and male gender, type of surgery (LF considered referent), hypoesthesia of the surgical area, seroma formation (binary: presence or absence), hematoma (binary: presence or absence), partial wound dehiscence (binary: presence or absence), wound infection (binary: presence or absence), and maceration (binary: presence or absence) as categorical variables. A p value <0.05 was considered statistically significant.

Results

In total, 343 patients scheduled for surgery due to PSD were invited to participate in the study. Thirteen patients

refused to participate; thus, 330 patients were included in the study. These patients were divided into the three groups by drawing lots (110 patients in each surgical group). Thirty-five patients (14 patients from the LF group, 2 patients from the MLF group, and 19 patients from the KF group) were lost to follow-up; they either did not attend the follow-up visits or could not be reached. Accordingly, data of 295 patients were analyzed (Fig. 4). The median age of the 295 patients was 24 years (range 18–39 years). Fifty-five (18.6 %) of these patients were females and 240 (81.4 %) were males. Ninety-six (32.5 %) were in the LF group, 108 (36.6 %) were in the MLF group, and 91 (30.8 %) were in the KF group. Patient demographics and results are shown in Table 1. The patients were followed up for a median of 33 months (range 24–41 months). There were more female patients in the LF group. The rate of seroma formation was higher in the KF group (19.8 %) compared to the LF and MLF groups (5.2 and 7.4 %, respectively; $p = 0.027$). The rate of wound dehiscence was higher in the KF group (15.4 %) compared to the LF and MLF groups (2.1 and 3.7 %, respectively; $p < 0.001$) as was the incidence of flap maceration (11 % in the KF vs. 1 % in the LF and 3.7 % in the MLF; $p = 0.004$). The incidence of PSD recurrence was also higher in the KF group (11 %) compared to the LF and MLF groups (6.3 and 1.9 %, respectively; $p = 0.027$). The rate of patient satisfaction (reported as excellent or good) at the end of 1 year was 74.2 %. No significant difference was found between the surgery groups in terms of the rate of satisfaction.

Recurrence was identified in 18 (6.1 %) patients. The median time until recurrence was 8 months (range 3–24 months). The rates of seroma formation, partial wound dehiscence, hematoma development, wound infection, and maceration were significantly higher in the group with recurrence than in the group without recurrence. The rate of patient satisfaction was found to be significantly higher in the group without recurrence. Additionally, in the group without recurrence, 94.7 % of the patients stated that they would recommend the surgical procedure, which they had undergone, to other patients with the same disease compared to only 32.3 % of the group with recurrence (Table 2). In a multivariate binary logistic regression model, the presence of seroma, hematoma, and wound infection were determined as statistically significant risk factors for recurrence (Table 3).

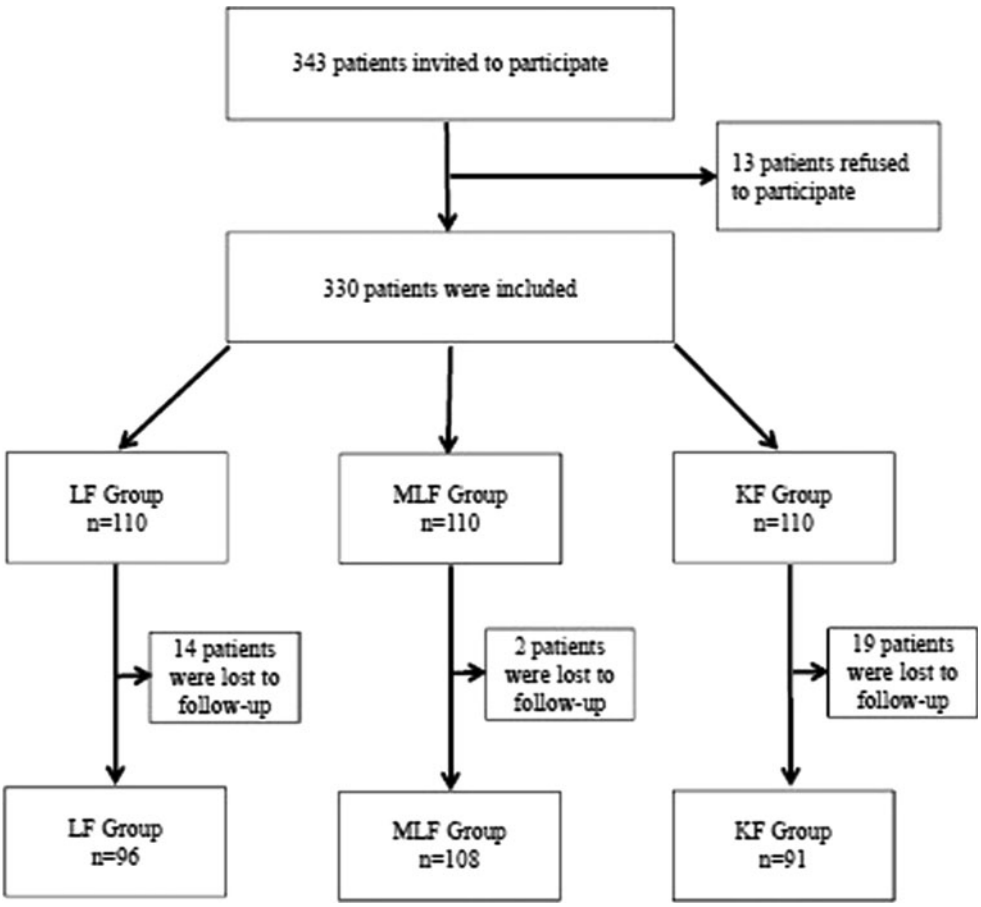

Fig. 4 Treatment flow chart

Table 1 Characteristics of the patients according to surgery groups

	Surgery group			
	LF ($n = 96$)	MLF ($n = 108$)	KF ($n = 91$)	p
Gender				
Female	28 (29.2)	13 (12.0)	14 (15.4)	**0.005**
Male	68 (70.8)	95 (88.0)	77 (84.6)	
Age (years)	26.5 ± 5.9	24.7 ± 5.1	24.7 ± 5.1	0.085
Duration of surgery (min)	51.1 ± 6.8	52.9 ± 7.3	50.9 ± 7.3	0.081
Duration of drainage (days)	3.1 ± 1.3	3.2 ± 1.3	3.1 ± 1.3	0.860
Length of hospital stay (days)	1.3 ± 0.5	1.3 ± 0.4	1.3 ± 0.4	0.507
Time until return to work (days)	20.8 ± 6.5	19.8 ± 4.6	19.1 ± 3.4	0.063
Time until complete healing (days)	29.0 ± 9.9	30.9 ± 10.9	30.9 ± 10.7	0.470
Seroma	5 (5.2)	8 (7.4)	18 (19.8)	**0.002**
Partial wound dehiscence	2 (2.1)	4 (3.7)	14 (15.4)	**<0.001**
Hypoesthesia of the surgical area	20 (20.8)	24 (22.2)	6 (6.6)	**0.006**
Hematoma	4 (4.2)	3 (2.8)	3 (3.3)	0.919
Wound infection	2 (2.1)	5 (4.6)	6 (6.6)	0.322
Maceration	1 (1.0)	4 (3.7)	10 (11.0)	**0.004**
Recurrence	6 (6.3)	2 (1.9)	10 (11.0)	**0.027**
Time until recurrence (months)	7.3 ± 3.4	12.9 ± 7.0	9.1 ± 5.2	0.161
Follow-up period (months)	34.5 ± 5.3	32.9 ± 4.6	33.3 ± 5.4	0.077
Patient satisfaction (in the 1st year)				
Excellent	30 (31.3)	41 (38.0)	30 (33.0)	0.733
Good	41 (42.7)	43 (39.8)	34 (37.4)	
Not bad	19 (19.8)	18 (16.7)	17 (18.7)	
Bad	6 (6.3)	6 (5.6)	10 (11.0)	
Recommending the surgical procedure to those with the same disease (in the 1st year)	86 (89.6)	98 (90.7)	76 (83.5)	0.253

Bold values indicate statistical significance

Data are presented as mean ± standard deviation, median (minimum–maximum) or number (%), where appropriate

LF Limberg flap, *MLF* Modified Limberg flap, and *KF* Karydakis flap

Discussion

Although many methods, either surgical or non-surgical, are being used for the treatment of pilonidal sinus, which method is the most appropriate is still a matter of debate. Complications and recurrence, in particular, are the most important problems. Investigations for an efficient and safe method that would reduce the risk of recurrence to a minimum, modifications of current methods and studies comparing the methods are still being conducted. Crystallized phenol treatment, which is one of the non-surgical methods, is being used as a simple and inexpensive method, and successful outcomes have been reported [8, 9].

A series of procedures are being used in surgical treatment and different outcomes are being reported. There are several studies that have showed superiority of flap repair to primary closure techniques [10–14]. In recent years, we have also preferred flap repair in our clinic.

Limberg flap surgery is recommended by many centers as a simple, effective method associated with low recurrence. Daphan et al. [15] treated 147 male patients with LF repair and reported seroma development to be 2 %, partial wound dehiscence to be 4.1 %, and recurrence to be 4.8 % within a mean follow-up period of 13 months. Kapan et al. [16] followed up 85 patients for 9–120 months after LF surgery and found the complication and recurrence rates to be 4.7 and 3.5 %, respectively. Eryilmaz et al. [17] reported a recurrence rate of 3 % in patients ($n = 63$) followed for 4–52 months after LF. Mentes et al. [18] found the recurrence rate to be 3.1 % after a 24-month follow-up period in 353 patients undergoing LF surgery. They reported the important advantages of the LF procedure as quick healing time, short length of hospital stay, early return to normal activities, and low complication and recurrence rates. In their study, Topgul et al. [19] determined the recurrence rate to be 2.5 % in patients undergoing LF surgery ($n = 200$).

Table 2 Characteristics of the groups with and without recurrence

	Recurrence		
	No ($n = 277$)	Yes ($n = 18$)	p
Gender			
Female	53 (19.1)	2 (11.1)	0.145
Male	224 (80.9)	16 (88.9)	
Age (years)	25.2 ± 5.7	25.5 ± 4.9	0.582
Duration of surgery (min)	47.9 ± 11.0	43.7 ± 12.6	0.073
Duration of drainage (days)	3.1 ± 1.3	3.1 ± 1.3	0.833
Length of hospital stay (days)	1.3 ± 0.5	1.2 ± 0.4	0.468
Time until return to work (days)	17.7 ± 5.5	16.6 ± 4.2	0.338
Time until complete healing (days)	30.7 ± 10.7	27.1 ± 8.6	0.108
Seroma	22 (7.9)	9 (50.0)	**<0.001**
Partial wound dehiscence	16 (5.7)	4 (22.2)	**0.025**
Hypoesthesia of the surgical area	46 (16.6)	4 (22.2)	0.526
Hematoma	8 (2.9)	2 (11.1)	**0.013**
Wound infection	10 (3.6)	3 (16.7)	**0.001**
Maceration	11 (3.9)	4 (22.2)	**0.002**
Follow-up period (months)	33.2 ± 5.0	32.7 ± 4.6	0.580
Patient satisfaction (in the 1st year)			
Excellent	97 (36.7)	4 (12.9)	**<0.001**
Good	115 (43.6)	3 (9.7)	
Not bad	45 (17.0)	9 (29.0)	
Bad	7 (2.7)	15 (48.4)	
Recommending the surgical procedure to those with the same disease (in the 1st year)	250 (94.7)	10 (32.3)	**<0.001**

Bold values indicate statistical significance

Table 3 Risk factors that affect the development of recurrence

	p	Odds ratio (95 % CI min–max)
Time until complete healing	0.099	0.964 (0.922–1.007)
Seroma	**<0.001**	7.920 (3.057–20.520)
Hematoma	**0.009**	7.690 (1.680–35.189)
Infection	**<0.001**	14.609 (4.086–52.237)

Bold values indicate statistical significance

CI confidence interval, *min* minimum, *max* maximum

Müller et al. [20] found a complication rate of 25.7 % and a recurrence rate of 1.6 % within a median follow-up period of 1.4 years (range 1–2.8 years) in 57 patients undergoing LF surgery. In the present study, the recurrence rate was determined to be 6.3 % in the LF group ($n = 96$) within a median follow-up of 35.5 months.

Mentes et al. [6] performed LF surgery on 40 patients and then modified the method and performed MLF surgery on 198 patients. While they observed three recurrences in patients undergoing LF surgery within a follow-up period of 12–38 months, they noted no recurrence in those undergoing MLF surgery. In the study by Kaya et al. [21], the recurrence rate was reported to be 4.2 % in 94 patients undergoing MLF surgery within a mean follow-up period of 30 months (range 12–54 months). In the same study, they reported the mean operative time to be 38.95 ± 6.77 min, wound dehiscence to be 1.1 %, seroma development to be 2.1 %, wound infection to be 5.3 %, maceration of the surgical incision site to be 8.5 %, and hypoesthesia to be 9.6 %. In the present study, recurrence rate was found to be 1.9 % in the MLF group ($n = 108$) within a median follow-up period of 34 months.

KF surgery has been reported to be feasible, safe, and effective as a day case surgical procedure and is preferred in some centers. Anderson et al. [22] prospectively followed up 51 patients and observed no recurrence after KF surgery. They also reported that 95 % of the patients returned to their normal daily activities within a month. In their study, Keshava et al. [23] performed KF surgery on 70 patients and determined a recurrence rate of 4.2 %

within a follow-up period ranging from 1 to 79 months. Kitchen [24] followed up 69 % of 114 patients who underwent KF surgery for more than 18 months and found the recurrence rate to be 4 %. Kulacoğlu et al. [25] used modified KF in 14 patients and reported no recurrence. In the present study, recurrence rate within a median follow-up period of 31 months was found to be 11 % in 91 patients undergoing KF surgery.

In the literature, there are studies that compare different types of surgery. While some studies generally compare primary closure and flap procedures, some compare different types of flap. Akin et al. [26] retrospectively evaluated 416 patients and compared the outcomes of classic LF ($n = 211$) and MLF ($n = 205$) repairs. They found no significant difference between the groups in terms of age, gender, follow-up period, length of hospital stay, and hypoesthesia. They reported that the MLF group had better clinical outcomes and a lower recurrence rate (4.73 % in the LF group and 0.97 % in the MLF group, $p = 0.03$). In addition, they determined that time until return to work was shorter and the rates of maceration and wound infection were lower in MLF group. In a randomized prospective study, Can et al. [27] compared MLF ($n = 72$) and KF ($n = 73$) procedures and reported longer operation times in the MLF group. In addition, they determined no significant difference between the groups in terms of complication rate, length of hospital stay, recurrence rate, degree of satisfaction, and the rate of patients recommending the same surgical procedure to other patients. Cihan et al. [13] retrospectively evaluated LF ($n = 40$), MLF ($n = 44$), and primary closure ($n = 78$) methods. For the surgical treatment of sacrococcygeal PSD, they suggested that LF or MLF reconstruction was superior to primary closure with respect to infection, time until mobilization, discharge from hospital and time off work. Moreover, they determined that MLF reconstruction was associated with a statistically lower recurrence rate as compared with primary closure. Four-year recurrence rates were reported to be 17.9 % in the primary closure group, 7.5 % in the LF group, and 0 % in the MLF group. In their study, Ates et al. [28] compared the results of 135 KF and 134 LF procedures in a prospective randomized study. The mean duration of surgery was significantly shorter in the KF group than in the LF group (42.32 ± 8.64 vs. 50.14 ± 6.96 min). The complication rate was 11.1 % for KF and 20.8 % for LF ($p = 0.02$), whereas the recurrence rate was 3 % for KF and 6.9 % for LF ($p = 0.15$). Petersen et al. [29] compared the patients who underwent KF surgery ($n = 97$) and excision only ($n = 91$) and reported the overall complication rates to be 21 and 2 %, respectively. They concluded that in the majority of patients in the KF group, there was primary healing despite the considerable wound-related complication rate. They reported no association between the complication rate and degree of contamination in the KF group; thus, they suggested KF surgery as a potential alternative to simple excision in infected PSD. In the study by Polat et al. [30], KF ($n = 15$) and primary closure techniques ($n = 33$) were compared and the rates of early recurrence were found to be 6.7 and 3 %, respectively. They reported primary closure to be an advantageous and preferable method. In the study by Saylam et al. [31], four methods including primary closure, D-flap, KF, and LF were compared. Although they observed the lowest recurrence rate in the primary closure group (7.5 %) and the highest recurrence rate in the KF group (13.5 %), they did not note a statistically significant difference between the groups in terms of recurrence rates. Horwood et al. [32] conducted a meta-analysis of randomized controlled studies that compared primary closure and LF procedures. They concluded that the use of rhomboid flap excision and LF-repair procedures rather than primary midline suture techniques are supported by the current published literature for the elective management of primary PSD. They also suggested that further high-quality studies comparing flap with off-midline repairs need to be conducted.

Different rates of reported recurrence are associated with various variables. Postoperative remnants may cause the recurrence of a disease, and the degree of inflammation influences the treatment and recurrence. Since recurrence is a time-dependent condition, a prolonged follow-up period may increase the rate of observed recurrence [33]. It has been reported that 60 % of recurrences occur within the first 5 years and 12–15 % of recurrences occur within the first year [33]. In most of the studies, the follow-up period is approximately 1–2 years. Further studies that compare different methods within longer follow-up periods are needed to obtain a more accurate assessment of recurrence.

In the present study, we compared LF, MLF, and KF procedures. The overall recurrence rate was found to be 6.1 % and was higher in the KF group than in the LF ($p = 0.105$) and MLF ($p = 0.07$) groups. Although the reason was not clear, we found the recurrence rate to be slightly higher than that reported in the literature. The recurrence rate was lower in the MLF group than in the LF group; however, the difference was not statistically significant (1.9 vs. 6.3 %; $p = 0.105$). Since operative time (51.1 ± 6.8 min for the LF group and 52.9 ± 7.3 min for the MLF group; $p = 0.753$) and complication rates (35.4 % for the LF group and 44.4 % for the MLF group; $p = 0.121$) were similar in the LF and MLF groups and recurrence is the most important parameter after PSD treatment, MLF could be the treatment of choice. It is our opinion that modification of the LF procedure is of importance and we recommend its use. No difference was found between the surgery groups in terms of age, operative time, duration of drainage, length of hospital stay, time

until return to work and time until complete healing. There was no difference between the groups with and without recurrence as regards the above-mentioned parameters. There were more female patients in the LF group than in the other two groups. Nevertheless, there was no difference between the groups with and without recurrence in terms of gender, and a multivariate binary logistic regression model revealed that gender was not a significant risk factor for recurrence.

Among complications, the rates of seroma formation, partial wound dehiscence, and maceration were significantly higher, whereas hypoesthesia of the surgical area was significantly lower in the KF group. No difference was found between the surgery groups in terms of hematoma and wound infection. Comparison of the groups with and without recurrence revealed that the incidence rates of all complications, except for hypoesthesia of the surgical area, were significantly higher in the group with recurrence. In a multivariate binary logistic regression model, seroma formation, hematoma formation, and wound infection were found to be significant risk factors for recurrence.

The patients in all the 3 groups were followed up for at least 24 months and no difference was found between the groups in terms of time until recurrence. Moreover, there was no difference between the groups with and without recurrence in terms of follow-up period. At the end of the 1-year follow-up period, no difference was found between the surgery groups in terms of degree of patient satisfaction and rate of recommending the surgical procedure to the other patients. However, degree of patient satisfaction and rate of recommending the surgical procedure to the other patients were significantly higher in the group without recurrence.

A limitation of the present study was that the procedures were performed by different surgeons.

Conclusions

KF surgery appeared to be disadvantageous due to higher complication and recurrence rates. In the present study, the LF and MLF procedures were found to be associated with similar lower complication and recurrence rates. More randomized studies with longer follow-up period are needed concerning the preferred surgical method for the treatment of PSD.

Conflict of interest None.

References

1. Lee PJ, Raniga S, Biyani DK, Watson AJ, Faragher IG, Frizelle FA (2008) Sacrococcygeal pilonidal disease. Colorectal Dis 10:639–650; discussion 651–652
2. Humphries AE, Duncan JE (2010) Evaluation and management of pilonidal disease. Surg Clin North Am 90:113–124
3. Thompson MR, Senapati A, Kitchen P (2011) Simple day-case surgery for pilonidal sinus disease. Br J Surg 98:198–209
4. Harlak A, Mentes O, Kilic S, Coskun K, Duman K, Yilmaz F (2010) Sacrococcygeal pilonidal disease: analysis of previously proposed risk factors. Clinics (Sao Paulo) 65:125–131
5. Azab AS, Kamal MS, Saad RA, Abou al Atta KA, Ali NA (1984) Radical cure of pilonidal sinus by a transposition rhomboid flap. Br J Surg 71:154–155
6. Mentes BB, Leventoglu S, Cihan A, Tatlicioglu E, Akin M, Oguz M (2004) Modified Limberg transposition flap for sacrococcygeal pilonidal sinus. Surg Today 34:419–423
7. Karydakis GE (1992) Easy and successful treatment of pilonidal sinus after explanation of its causative process. Aust N Z J Surg 62:385–389
8. Dogru O, Camci C, Aygen E, Girgin M, Topuz O (2004) Pilonidal sinus treated with crystallized phenol: an eight-year experience. Dis Colon Rectum 47:1934–1938
9. Aygen E, Arslan K, Dogru O, Basbug M, Camci C (2010) Crystallized phenol in nonoperative treatment of previously operated, recurrent pilonidal disease. Dis Colon Rectum 53:932–935
10. Mahdy T (2008) Surgical treatment of the pilonidal disease: primary closure or flap reconstruction after excision. Dis Colon Rectum 51:1816–1822
11. Muzi MG, Milito G, Cadeddu F et al (2010) Randomized comparison of Limberg flap versus modified primary closure for the treatment of pilonidal disease. Am J Surg 200:9–14
12. Roshdy H, Ali Y, Askar W, Awad I, Farid M (2010) Rhomboid flap versus primary closure after excision of sacrococcigeal pilonidal sinus (a prospective randomized study). Egyp J Surg 29:146–152
13. Cihan A, Mentes BB, Tatlicioglu E, Ozmen S, Leventoglu S, Ucan BH (2004) Modified Limberg flap reconstruction compares favourably with primary repair for pilonidal sinus surgery. ANZ J Surg 74:238–242
14. Ersoy OF, Karaca S, Kayaoglu HA, Ozkan N, Celik A, Ozum T (2007) Comparison of different surgical options in the treatment of pilonidal disease: retrospective analysis of 175 patients. Kaohsiung J Med Sci 23:67–70
15. Daphan C, Tekelioglu MH, Sayilgan C (2004) Limberg flap repair for pilonidal sinus disease. Dis Colon Rectum 47:233–237
16. Kapan M, Kapan S, Pekmezci S, Durgun V (2002) Sacrococcygeal pilonidal sinus disease with Limberg flap repair. Tech Coloproctol 6:27–32
17. Eryilmaz R, Sahin M, Alimoglu O, Dasiran F (2003) Surgical treatment of sacrococcygeal pilonidal sinus with the Limberg transposition flap. Surgery 134:745–749
18. Mentes O, Bagci M, Bilgin T, Ozgul O, Ozdemir M (2008) Limberg flap procedure for pilonidal sinus disease: results of 353 patients. Langenbecks Arch Surg 393:185–189
19. Topgül K, Ozdemir E, Kiliç K, Gökbayir H, Ferahköşe Z (2003) Long-term results of limberg flap procedure for treatment of pilonidal sinus: a report of 200 cases. Dis Colon Rectum 46:1545–1548
20. Müller K, Marti L, Tarantino I, Jayne DG, Wolff K, Hetzer FH (2011) Prospective analysis of cosmesis, morbidity, and patient satisfaction following Limberg flap for the treatment of sacrococcygeal pilonidal sinus. Dis Colon Rectum 54:487–494
21. Kaya B, Eris C, Atalay S et al (2012) Modified Limberg transposition flap in the treatment of pilonidal sinus disease. Tech Coloproctol 16:55–59
22. Anderson JH, Yip CO, Nagabhushan JS, Connelly SJ (2008) Day-case Karydakis flap for pilonidal sinus. Dis Colon Rectum 51:134–138

23. Keshava A, Young CJ, Rickard MJ, Sinclair G (2007) Karydakis flap repair for sacrococcygeal pilonidal sinus disease: how important is technique? ANZ J Surg 77:181–183
24. Kitchen PR (1996) Pilonidal sinus: experience with the Karydakis flap. Br J Surg 83:1452–1455
25. Kulacoglu H, Dener C, Tumer H, Aktimur R (2006) Total subcutaneous fistulectomy combined with Karydakis flap for sacrococcygeal pilonidal disease with secondary perianal opening. Colorectal Dis 8:120–123
26. Akin M, Leventoglu S, Mentes BB 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 40:757–762
27. Can MF, Sevinc MM, Hancerliogullari O, Yilmaz M, Yagci G (2010) Multicenter prospective randomized trial comparing modified Limberg flap transposition and Karydakis flapreconstruction in patients with sacrococcygeal pilonidal disease. Am J Surg 200:318–327
28. Ates M, Dirican A, Sarac M, Aslan A, Colak C (2011) Short and long-term results of the Karydakis flap versus the Limberg flap for treating pilonidal sinus disease: a prospective randomized study. Am J Surg 202:568–573
29. Petersen S, Aumann G, Kramer A, Doll D, Sailer M, Hellmich G (2007) Short-term results of Karydakis flap for pilonidal sinus disease. Tech Coloproctol 11:235–240
30. Polat N, Albayrak D, İbiş AC, Altan A (2008) Comparison between Karydakis flap repair and primary closure for surgical treatment of sacrococcygeal pilonidal sinüs. Trakya Univ Tıp Fak Derg 25:87–94
31. Saylam B, Balli DN, Düzgün AP, Ozer MV, Coşkun F (2011) Which surgical procedure offers the best treatment for pilonidal disease? Langenbecks Arch Surg 396:651–658
32. Horwood J, Hanratty D, Chandran P, Billings P (2012) Primary closure or rhomboid excision and Limberg flap for the management of primary sacrococcygeal pilonidal disease? A metaanalysis of randomized controlled trials. Colorectal Dis 14:143–151
33. Doll D (2010) 5- and 10-year recurrence rate is the new gold standard in pilonidal sinus surgery benchmarking. Med Princ Pract 19:216–217