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ORIGINAL ARTICLE

A comparative analysis of four different surgical methods for treatment of sacrococcygeal pilonidal sinus

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Primary closure;
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Summary *Objectives:* Although many surgical methods have been described for sacrococcygeal pilonidal sinus treatment, the best option is still controversial. We aimed to compare postoperative outcomes of these different methods in terms of advantages and disadvantages.
Methods: The records of 320 patients undergone surgery for primary or recurrent pilonidal sinus between May 2013 and May 2017 were retrospectively analyzed. Demographical data, pre operative stories, wound site infection, seroma development, wound dehiscence, time of healing, duration of return to work, and if there is any recurrence of 303 patients included in the study were recorded. Upon wide local excision, the first surgeon performed marsupialisation and the lay open technique, second surgeon performed vertical excision and primary closure, third surgeon performed Limberg flap transposition and fourth surgeon performed Karydakis' flap transposition.
Results: There was no significant difference between the patients in terms of demographical characteristics. The duration of surgery was statistically significantly higher in primary closure method ($p = 0.001$). The mean duration of return-to-work was statistically significantly lower in primary closure method ($p = 0.002$). In primary closure method, the recurrence rate was found to be statistically significantly higher than the other methods ($p = 0.009$).
Conclusion: We do not suggest the use of primary closure method in treatment of pilonidal sinus. Because of lower rates of recurrence and shorter durations of return to work, the Karydakis and Limberg methods are seen as safer methods when compared to lay-open and marsupialization method.

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1. Introduction

Pilonidal sinus is an infectious disease prevalently observed in the natal cleft and sacrococcygeal region. It generally affects young, working-class males in the age group of 15—30 years[1] and has a reported incidence rate of 26/10.000 people per year.[2] Despite the old theories arguing that pilonidal sinus is congenital, it is currently considered an acquired condition.[3] The causative factors usually include keratin plugs, presence of dermopathy, hair remnants in the natal cleft and foreign body reactions related to hair.[4] Although various surgical methods have been described for the treatment of patients with pilonidal sinus to date, the ideal treatment remains debatable. A widely accepted method, that decreases complication and recurrence rates and provides cosmetically acceptable outcomes and short recovery period, currently remains unavailable. However, the commonly used methods include Limberg flap transposition, Karydakis flap transposition and primary closure or allowing healing by secondary intention following the complete excision of the cyst.[5] The aim of this study was to compare the advantages and disadvantages of these different methods in terms of postoperative outcomes.

2. Methods

2.1. Study patients

The records of 320 patients who were operated for primary or recurrent pilonidal sinus between May 2013 and May 2017 were retrospectively reviewed. Of these, 17 patients who missed the scheduled follow-ups were excluded from the study. The patients were operated by either of four surgeons each of who tended to use a different method. The patients were classified according to surgical methods used. The demographic data of the 303 patients included in the study were recorded. Preoperative presence of an infection or abscess, drain placement during surgery, time of drain removal and early postoperative complications were examined. Follow-up was scheduled for all patients as control visits at 5 and 10 days following discharge; they were evaluated for the development of wound site infection or seroma and wound dehiscence. The sutures were removed on an average of 2 weeks following discharge. Later, annual follow-ups were continued after 1-, 3- and 6-month follow-ups. Recovery time, time to return to work and presence of recurrence within a mean follow-up of 22.3 $\pm$ 6.4 (13—48) months were recorded.

The patients with preoperative active infection were operated following the administration of antibiotic treatment, whereas those admitted with acute abscess were operated 7—10 days after abscess drainage and administration of antibiotic treatment. All patients preoperatively received prophylactic administration of 1 g Cefazolin. During operations, the patients were positioned in the jack-knife position, with the gluteus being retracted from both sides. Upon wide local excision, the first surgeon performed marsupialisation and the lay open technique, second surgeon performed vertical excision and primary closure, third surgeon performed Limberg flap transposition and fourth surgeon performed Karydakis' flap transposition. Drain placement was performed in all patients who underwent Limberg flap transposition and primary closure, and drains were removed when the drainage volume decreased to less than 20 cc/day. Presence of erythema, local warmth and drainage of purulent materials were considered the signs of wound site infection.

2.2. Surgical method

2.2.1. Marsupialisation and lay open technique

En bloc excision of the sinus was performed using a healthy tissue up to the presacral fascia following the construction of an elliptical incision encompassing all external orifices. Mattress sutures were used which passed through the following in this order: skin, subcutaneous tissue, fascia and skin. Upon placement of all sutures, the suturing material was secured without gaps.

2.2.2. Primary closure

The sinus was removed as a whole with the healthy tissue up to the presacral fascia following the construction of an elliptical incision including all external orifices.A drain was placed into the cavity, and the subcutaneous tissues were approximated by placing 2/0 absorbable sutures passing through the subcutaneous tissue and presacral fascia. Then, the skin was closed with a 3/0 non-absorbable suture.

2.2.3. Limberg flap transposition

The tissue was excised up to the presacral fascia following the construction of a rhomboid incision encompassing all sinus openings. One end of the incision was extended up to a similar length. A flap was prepared such as to include the gluteal muscle fascia. Then, a drain was placed in the cavity and one end of the drain was transported outside the skin. Following the stabilisation of the bottom of the flap to the presacral fascia in the cavity, the subcutaneous tissues were closed with absorbable suture number 1. Next, the skin was closed with a 2/0 non-absorbable monofilament suture.

2.2.4. Karydakis' flap transposition

An asymmetric and biconcave elliptical incision was constructed en compassing the external orifices of the sinus. In the presence of a secondary cavity or induration on one side of the ellipse, the incision was moved towards that

side. The vertical length of the incision was maintained at a minimum of 5 cm, and its medial and lateral edges were maintained at a 2-cm distance from the centre of the ellipse. A flap was prepared through the whole incision in the medial edge of the incision using a cautery at a 1-cm depth, maintaining it 2-cm inwards. Then, absorbable sutures were used in the fatty tissue of the prepared flap, passing through both surfaces. Later, a series of 2/0 absorbable suture material and a series of sutures were placed along the entire flap such as to pass them through the midline of the presacral fascia. A second line of sutures with 2/0 absorbable suture material was placed between the bottom surface of the flap and fat tissue in the lateral to approximate these two layers. Later, the skin was closed with a 3/0 non-absorbable suture.

2.3. Statistical analysis

For statistical analyses, SPSS 15.0 for Windows software package was used. Descriptive statistics are presented as number and percentage for categorical variables and as mean, standard deviation and minimum-maximum for numerical variables. Because the numerical variables did not show normal distribution, comparisons of more than two groups were performed using Kruskal–Wallis test. Further, subgroup comparisons were performed using Mann–Whitney *U*-test and interpreted with Bonferroni correction. The rates in the groups were compared with chi-square test, and Monte Carlo simulation was performed for multi-span cell tables when Pearson'schi-square assumptions were not met. Statistical alpha significance level was accepted as $p < 0.05$.

The study design was in accordance with the guidelines of the Declaration of Helsinki (Second revision, 2008) and approved by the local ethics committee (09.05.2018/94-6).

3. Results

Of the included patients, 244 (80.5%) were male and 59 (19.5%) were female, and the mean age was 24.0 ± 6.7 (14–50) years. Further, 270 (89.1%) patients were operated due to primary pilonidal sinus and 33 (10.9%) due to recurrent pilonidal sinus. Notably, there was no significant difference among the groups in terms of age and body mass index. Prior to operations, abscess drainage and antibiotherapy were performed in 22 (7.1%) patients, whereas 82 (26.7%) patients received antibiotherapy due to the presence of an infected sinus. Following total excision, 114 (37.6%) patients underwent Limberg flap transposition, 81 (26.7%) underwent Karydakis' flap transposition, 55 (18.2%) underwent primary closure and 53 (17.5%) underwent marsupialisation and wounds were allowed to heal by secondary intention (Table 1).

Irrespective of the groups, the mean operative time for all patients was 35.2 ± 8.7 (20–60) min. A drain was placed in 164 (54.1%) patients, and the mean time to drain removal was 2.3 ± 0.6 (1–6.5) days.The mean length of hospital stay was 2.1 ± 1.1[1–7] days for all patients, whereas the mean time to return to work was 10.7 ± 6.5 (1–79) days. The patients were followed up for a mean duration of 22.3 ± 6.4 (13–48) months. Wound site infection was observed in 47 (15.5%) patients, seroma in 16 (5.3%), wound dehiscence in 4 (1.3%) and recurrence in 13 (4.3%) (Table 2).

When the patients were grouped according to surgical methods, no significant difference was observed among the

Table 1 General distribution of all patients.

Age Mean ± SD (Min-Max)		24.0 ± 6.7 (14–50)
Gender n (%)	Male	244 (80.5)
	Female	59 (19.5)
BMI Mean ± SD (Min-Max)		25.3 ± 3.5 (15.17–44.5)
Primary/Recurrent	Primary	270 (89.1)
	Recurrent	33 (10.9)
Preoperative Infection n (%)	Infected	82 (27.1)
	Uninfected	221 (72.9)
Primary disease, n (%)		270 (89.1)
	Lay open	46 (17)
	Primary closure	44 (16.3)
	Limberg Flap	105 (38.9)
	Karydakis' Flap	75 (27.8)
Recurrent disease, n (%)		33 (10.9)
	Lay open	7 (21.2)
	Primary closure	11 (33.3)
	Limberg Flap	9 (27.7)
	Karydakis' Flap	6 (18.1)
Preoperative Abscess Drainage n (%)		22 (7.1)

n: number.

Table 2 General view of all operated patients without group distinction.

Duration of operation (min), mean ± SD (Min-Max)	35.2 ± 8.7 (20–60)
Abscess drainage n (%)	22 (7.3)
Drain n (%)	164 (54.1)
Wound site infection n (%)	47 (15.5)
Wound dehiscence n (%)	4 (1.3)
Seroma n (%)	16 (5.3)
Duration of hospitalization (days)Mean ± SD (Min-Max)	2.1 ± 1.1 (1–7)
Return to work (days) Mean ± SD (Min-Max)	10.7 ± 6.5 (1–79)
Recurrence n (%)	13 (4.3)
Time of recurrence (months)Mean ± SD (Min-Max)	10.8 ± 7.7 (3–34)
Duration of follow-up (months)Mean ± SD (Min-Max)	22.3 ± 6.4 (13–48)

n: number.

Table 3 Evaluation of preoperative characteristics according to repair methods used.

		Lay Open	Primary Closure	Limberg Flap	Karydakis Flap	P value
Age Mean ± SD (Median)		25.5 ± 7.8 (24)	23.6 ± 5.3 (22)	24.1 ± 6.9 (22)	23.1 ± 6.2 (22)	0.276
Gender n (%)	Male	45 (84.9)	46 (83.6)	96 (84.2)	57 (70.4)	0.063
	Female	8 (15.1)	9 (16.4)	18 (15.8)	24 (29.6)	
BMI Mean ± SD (Median)		26.0 ± 3.1 (26.2)	25.6 ± 2.9 (26)	25.2 ± 3.7 (25)	25.3 ± 3.6 (25.1)	0.08
Primary/Recurrent	Primary	46 (86.8)	44 (80.0)	105 (92.1)	75 (92.6)	0.07
	Recurrent	7 (13.2)	11 (20.0)	9 (7.9)	6 (7.4)	
Preoperative infection n (%)	Infected	18 (34.0)	15 (27.3)	23 (20.2)	26 (32.1)	0.167
	Uninfected	35 (66.0)	40 (72.7)	91 (79.8)	55 (67.9)	

n: number.

groups in terms of demographic data such as age, sex and BMI. Similarly, presence of preoperative infection was not significant among the groups. Further, there was no significant difference among the groups regarding whether operation was performed due to primary or relapse pilonidal sinus (Table 3).

When the patients were grouped according to the methods used, a significant difference was observed among the groups in terms of the mean operative time, drain usage rates and mean time to return to work ($p = 0.009$, <0.001 and 0.009, respectively). The operative time was significantly longer in the primary closure group than in the other groups ($p = 0.001$). It was believed that this longer time was due to surgeon-specific factors. No drain was placed for the lay open and Karydakis' flap transposition groups. The rate of drain usage was higher for the primary closure and Limberg flap transposition groups. Further, the mean time to return to work was significantly lower for the primary closure group than for the other groups ($p = 0.002$). While there was no significant difference in terms of follow-up duration among the groups, the prevalence of relapse within the follow-up period was found to be significantly higher in the primary closure group than in the other groups ($p = 0.009$). Notably, there were no significant differences among the groups in terms of wound site infection, wound dehiscence and development of seroma (Table 4).

When the groups were classified according to surgery for relapse or primary pilonidal sinus, there was no significant difference between the relapse and primary patients in terms of postoperative complications (Table 5).

4. Discussion

The debate over the treatment of pilonidal sinus remains unsettled to date. However, maintenance of adequate hygiene and removal of the hair in the related region are accepted as prerequisites for its treatment.[6] Wound care following pilonidal sinus surgery is a difficult process requiring close monitoring. Various methods have been described for the treatment of patients with pilonidal sinus, but high recurrence rates continue to be an important problem.[7] Secondary infections have been implicated as the cause of early recurrence, whereas an inability to eliminate the physiopathological process that has caused the disease has been associated with late recurrence.[3] Poor wound care, an inability to completely remove the cyst or draining tract, recurrent hair follicle infection and midline scars are considered the most important causes of recurrence.[3] Healing with granulation being more susceptible to hair penetration and flattening of the large natal cleft are factors that cause recurrence following treatment with the lay open technique.[8]

Table 4 Characteristics of operation according to pilonidal sinus repair methods.

	Lay-open	Primary closure	Limberg flap	Karidakis flap	P value
Duration of operation (minute) Mean ± SD (Median)	34.3 ± 6.4 (30)	39.3 ± 11.2 (35)	34.6 ± 7.9 (30)	33.7 ± 8.4 (30)	0.009[a]
Drain n (%)	0 (0.0)	52 (94.5)	112 (98.2)	0 (0.0)	<0.001[a]
Wound site infection n (%)	5 (9.4)	8 (14.5)	23 (20.2)	11 (13.6)	0.301
Wound dehiscence n (%)	0 (0.0)	2 (3.6)	0 (0.0)	2 (2.5)	0.099
Seroma n (%)	1 (1.9)	1 (1.8)	8 (7.0)	6 (7.4)	0.303
Duration of hospitalization (days) Mean ± SD (Median)	2.2 ± 1.2 (2)	2.2 ± 1.2 (2)	2.1 ± 1.0 (2)	1.9 ± 1.1 (2)	0.473
Return to work Mean ± SD (Median)	11.4 ± 4.0 (10)	9.5 ± 4.1 (8)	10.5 ± 7.0 (9)	11.3 ± 8.3 (10)	0.009[a]
Recurrence n (%)	3 (5.7)	5 (9.1)	3 (2.6)	2 (2.5)	0,01[a]
If recurrence occurred (months),Mean ± SD (Median)	10.0 ± 4.4 (12)	14.8 ± 10.9 (12)	7.0 ± 4.6 (6)	8.0 ± 2.8 (8)	–
Follow-up duration (months) Mean ± SD (Median)	21.8 ± 6.8 (21)	22.7 ± 6.8 (22)	22.7 ± 6.2 (23)	22.0 ± 6.1 (22)	0.681

n: number.
[a] Statistically significant.

Table 5 Evaluation depending on whether operation was performed due to primary or relapse pilonidal sinus.

	Lay-open	Primary closure	Limberg flap	Karidakis flap	P value
Wound site infection n (%)					
Primary disease	4 (80)	6 (75)	18 (78.2)	8 (72.7)	0.39
Recurrent disease	1 (20)	2 (25)	5 (21.8)	3 (27.3)	
Wound dehiscence n (%)					
Primary disease	0 (0,0)	2 (100)	0 (0.0)	2 (100)	–
Recurrent disease		0 (0)		0 (0)	
Seroma n (%)					
Primary disease	1 (100)	1 (100)	6 (75)	5 (83.3)	0.33
Recurrent disease	0 (0))	0	2 (25)	1 (16.7)	
Relapse n (%)					
Primary disease	2 (66.7)	4 (80)	2 (66.7)	2 (100)	0.34
Recurrent disease	1 (33.3)	1 (20)	1 (33.3)	0 (0)	

-: could not be calculated due to inadequate number of patients.

The most important causes of morbidity during the early postoperative period include wound site infections, seroma, wound dehiscence and flap necrosis.[9] Their prevalence rates vary depending on the surgical method used. An ideal method should reduce these complications while providing early recovery, early return to work and good cosmetic outcomes and have a low recurrence rate. The patients in the present study underwent Limberg flap transposition, Karydakis' flap transposition, primary closure and marsupialisation followed by allowing wound healing by secondary intention after performing total excision.

Reportedly, allowing wound healing by secondary intention is associated with shorter length of hospital stay and lower rate of recurrence, but no significant difference has been reported in terms of wound site infection.[2,9,10] The disadvantages of this method include prolonged wound healing and requirement of wound dressing for a longer period. However, there have also been studies reporting that postoperative infection is observed more frequently using the lay open technique than using the primary closure or other methods involving flap transposition.[11] In a meta-analysis conducted by McCallum et al., the time to return to work was reported to be 17 days using the lay open technique.[2] Recent studies have reported a recurrence rate of 1% during a 1-year follow-up and a rate of 14.3% during a 2-year follow-up.[12,13] In our study, the mean time to return to work was 10 (11.4 ± 4.0) days and the rate of recurrence was 5.7% during a 21-month follow-up in the patients who underwent marsupialisation and secondary wound healing.

Some authors consider primary midline closure following excision as a method that must be discontinued due to its considerably high recurrence rate and increased rate of wound complications,[13] but there are authors supporting its use in recent studies.[14] The rate of recurrence is reported to range from 4% to 28% using the primary closure method.[14–16] The rates for wound site infection, wound dehiscence and seroma are reported to be 9%–20%, 2.5%–16.9% and 0%–2%, respectively; the mean time to return to work was reported to be 8.5–14 days.[2,17–20] The recurrence rate was 9.1%, rate of wound site infection was 14.5%, rate of wound dehiscence was 3.6%, rate of seroma formation was 1.8% and mean time to return to work was 8 (9.5 ± 4.1) days in the patients who underwent primary closure.

The Karydakis' method involves reliving the pressure by a lateral shift of the midline. The objective is to flatten the natal cleft, thus decreasing hair collection and mechanical irritation, and to decrease the possibility of recurrence.[6,21] Karydakis reported a recurrence rate of 1%, complication rate of 8% and mean hospitalisation time of 3 days.[6] However, some authors have reported a recurrence rate of 1.5%–4.6% and complication rate of 6%–10%.[16,22] In a recent meta-analysis by Stauffer et al. who evaluated recurrences, the rate of recurrence was reported to be 1.5% during a 12-month follow-up, 2.4% during a 24-month follow-up and 10.2% during a 60-month follow-up (13). Bali et al. reported a wound site infection rate of 23.4%, seroma rate of 11.7%, wound dehiscence rate of 5.8% and recurrence rate of 0%. In the same study, the mean time to return to work was reported to be 17 days.[23] In the current study patients, the rate of recurrence during a 22-month follow-up was 2.5%. Wound site infection occurred in 13.6% patients, wound dehiscence occurred in 2.5% patients and seroma formation occurred in 7.4% patients. The mean length of hospital stay was 2 (1.9 ± 1.1) days, whereas the mean time to return to work was 10 (11.3 ± 8.3) days.

The objective of the Limberg flap repair is to decrease the tension by flattening the natal cleft as in Karydakis' flap transposition. It is one of the most frequently used reconstructive methods. Although there are reports recommending the closure of defects using Limberg flap transposition due to its low recurrence and complication rates,[23–26] there are reports arguing that the off-midline methods are not superior to each another.[9,27] Some authors even support the use of Karydakis flap repair rather than Limberg flap repair.[28] The recurrence rate of Limberg flap transposition was reported to be 0.8%–4.8%,[19,25,26,29,30] whereas the wound site complication rate was reported to be 4.2%–20.8%.[19,28,31] The mean length of hospital stay was reported to be 3.7–5.3 days and mean time to return to work was reported to be 7–8 days in the literature.[7–17] In the present study, the recurrence rate was found to be 2.6% during a mean follow-up of 23 (22.7 ± 6.2) months. The rate of wound site infection was

20.2% and that of seroma formation was 7%, whereas wound dehiscence did not occur in any of the patients. The mean length of hospital stay was 2 (2.1 ± 1.0) days and mean time to return to work was 9 (10.5 ± 7) days.

Evaluation of surgical methods in terms of their recurrence rates is closely related to the duration of the surgical follow-up period. The recurrence rates associated with the surgical method increases with increasing duration of follow-up.[13] The mean duration of follow-up being 22 months for the current patients is a limitation of the study. However, the presence of a few studies in the literature comparing four different methods performed by four different surgeons can be regarded as an advantage of this study. During follow-ups, the rate of recurrence was significantly higher among the patients who underwent primary closure following extensive excision than among the other patients ($p = 0.009$). Notably, there were no significant differences in terms of wound site infection, wound dehiscence and seroma formation. Moreover, the operative time was significantly longer with the primary closure method than with the other methods ($p = 0.001$), and mean time to return to work was significantly shorter ($p = 0.002$).

5. Conclusion

The authors of the present manuscript, considering the current study findings, do not recommend the use of primary closure method in the treatment of patients with pilonidal sinus. It appears that the Karydakis' and Limberg flap transposition methods are safer methods than primary closure, considering lower rates of recurrence and shorter time to return to work associated with these two methods.

Conflicts of interest

We have no conflict of interests and the study wasn't funded any agency or institution.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.asjsur.2018.12.011.

References

1. Isik A, Idiz O, Firat D. Novel approaches in pilonidal sinus treatment. *Prague Med Rep*. 2016;4(117):145–152.
2. McCallum IJ, King PM, Bruce J. Healing by primary closure versus open healing after surgery for pilonidal sinus: systematic review and meta-analysis. *BMJ*. 2008;336:868–871.
3. Hamaloğlu E, Yorgancı K. Pilonidal sinus. In: *İskender Sayek Ed. Sayek Temel Cerrahi*. 6th ed. Ankara: Güneş Tıp kitabevi; 2013: 1148–1150 [In Turkish].
4. Meinero P, Mori L, Gasloli G. Endoscopic pilonidal sinus treatment (E.P.Si.T.). *Tech Coloproctol*. 2014;18:389–392.
5. Sahsamanis G, Samaras S, Mitsopoulos G, Devrakis T, Dimitrakopoulos G, Pinailidis D. Semi-closed surgical technique for treatment of pilonidal sinus disease. *Ann Med Surg (Lond)*. 2017;3(15):47–51.
6. Karydakis GE. Easy and successful treatment of pilonidal sinus after explanation of its causative process. *Aust N Z J Surg*. 1992;62:385–389.
7. Urhan MK, Kucukel F, Topgul K, Ozer I, Sari S. Rhomboid excision and Limberg flap for managing pilonidal sinus: results of 102 cases. *Dis colon rectum*. 2002;45(5):656–659.
8. Humphries AE, Duncan JE. Evaluation and management of pilonidal disease. *Surg Clin*. 2010;90(1):113–124.
9. Iesalnieks I, Ommer A, Petersen S, Doll D, Herold A. German national guideline on the management of pilonidal disease. *Langenbeck's Arch Surg*. 2016;8(5):599–609.
10. AL-Khamis A, McCallum I, King PM, Bruce J. Healing by primary versus secondary intention after surgical treatment for pilonidal sinus. *Cochrane Database Syst Rev*. 2010 Jan 20;(1): CD006213.
11. Rashidian N, Vahedian-Ardakani J, Baghai-Wadji M, et al. How to repair the surgical defect after excision of sacrococcygeal pilonidal sinus: a dilemma. *J Wound Care*. 2014;23(12): 630–633.
12. Yıldırım O, Turan Ü, Ünal B, Kırımlıoğlu V. Sacrococcygeal pilonidal sinus. *İnönü Üniversitesi Tıp Fakültesi Dergisi*. 2008; 15(4):299–305 [In Turkish, English abstract].
13. 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.
14. Milone M, Velotti N, Manigrasso M, Anoldo P, Milone F, De Palma GD. Long-term follow-up for pilonidal sinus surgery: a review of literature with metanalysis. *Surgeon*. 2018;16(5): 315–320. https://doi.org/10.1016/j.surge.2018.03.009.
15. Muzi MG, Milito G, Nigro C, Cadeddu F, Farinon AM. A modification of primary closure for the treatment of pilonidal disease in day-care setting. *Colorectal Dis*. 2009;11(1):84–88.
16. Can MF, Sevinc MM, Yilmaz M. Comparison of Karydakis flap reconstruction versus primarymidline closure in sacrococcygeal pilonidal disease: results of 200 military service members. *Surg Today*. 2009;369(7):580–586.
17. Serour F, Somekh E, Krutman B, Gorenstein A. Excision with primary closure and suction drainage for pilonidal sinus in adolescent patients. *Pediatr Surg Int*. 2002;18(3):159–161.
18. Kaya B, Uçtum Y, Şimşek A, Kutaniş R. Treatment of pilonidal sinus with primary closure. A simple and effective method. *J Dis Colon Rectum*. 2010;20:59–65.
19. Kose E, Hasbahceci M, Tonyali H, Karagulle M. Comparative analysis of the same technique-the same surgeon approach in the surgical treatment of pilonidal sinus disease: a retrospective cohort study. *Ann Surg Treat Res*. 2017;93(2):82–87.
20. Sequeira JB, Coelho A, Marinho AS, Bonet B, Carvalho F, Moreira-Pinto J. Endoscopic pilonidal sinus treatment versus total excision with primary closure for sacrococcygeal pilonidal sinus disease in the pediatric population. *J Pediatr Surg*. 2018; 53(10):2000–2007.
21. Varnalidis I, Ioannidis O, Paraskevas G, et al. Pilonidal sinus: a comparative study of treatment methods. *J Med Life*. 2014; 7(1):27–30.
22. Sozen S, Topuz O, Donder Y, et al. Comparison between Karydakis flap repair and Limberg flap for surgical treatment of sacrococcygeal pilonidal sinus (short term results). *Turk J SurgSurg Clin*. 2010;26(3):153–156.
23. Bali İ, Aziret M, Sözen S, et al. Effectiveness of Limberg and Karydakis flap in recurrent pilonidal sinus disease. *Clinics(Sao Paulo)*. 2015;70(5):350–355.
24. Mentes BB, Leventoglu S, Cihan A, Tatlicioglu E, Akin M, Oguz M. Modified Limberg transposition flap for sacrococcygeal pilonidal sinus. *Surg Today*. 2004;34(5):419–423.
25. Ersoy E, Devay AO, Aktimur R, Doganay B, Ozdoğan M, Gündoğdu RH. Comparison of the short-term results after Limberg and Karydakis procedures for pilonidal disease:

randomized prospective analysis of 100 patients. *Colorectal Dis*. 2009;11(7):705—710.
26. Boshnaq M, Phan YC, Martini I, Harilingam M, Akhtar M, Tsavellas G. Limberg flap in management of pilonidal sinus disease: systematic review and a local experience. *Acta Chir Belg*. 2018;118(2):78—84.
27. Tokac M, Dumlu EG, Aydin MS, Yalcın A, Kilic M. Comparison of modified Limberg flap and Karydakis flap operations in pilonidal sinus surgery: prospective randomized study. *Int Surg*. 2015;100(5):870—877.
28. Ates M, Dirican A, Sarac M, Aslan A, Colak C. 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*. 2011;202(5):568—573.
29. Topgul K, Ozdemir E, Kilic K, Gokbayir H, Ferahkose Z. Long-term results of limberg flap procedure for treatment of pilonidal sinus: a report of 200 cases. *Dis Colon Rectum*. 2003; 46(11):1545—1548.
30. Daphan C, Tekelioglu MH, Sayilgan C. Limberg flap repair for pilonidal sinus disease. *Dis Colon Rectum*. 2004;47(2):233—237.
31. Karaca T, Yoldas Ö, Bilgi ÇB, Özer S, Yoldaş S, Karaca NG. Comparison of short-term results of modified Karydakis flap and modified Limberg flap for pilonidal sinus surgery. *Int J Surg*. 2012;10:601—606.