Outcome of dufourmentel flap versus conventional rhomboid (Limberg flap) in the treatment of complex pilonidal sinus: a randomized controlled study

Emad M. Abdelrahman[a], Elsayed O. Kilany[a], Ahmed A. Shoulah[b], Amal H. Ghazy[c], Sherif A. Elgazzar[a]

[a]Department of General Surgery, [b]Plastic Surgery Unit, Department of Surgery, Faculty of Medicine, Benha University, Benha, [c]Department of General Surgery, Al-Ahrar Teaching Hospital, Zagazig, Egypt

Correspondence to Emad M. Abdelrahman, MD, Fareed Nada Street, Benha 13518, Egypt. Tel: +20 122 676 3986; Fax: 0020133231888; e-mail: emadsahan301@gmail.com, emad.sarhan@fmed.bu.edu.eg

Received: 25 October 2023
Revised: 7 November 2023
Accepted: 19 November 2023
Published: 31 January 2024

The Egyptian Journal of Surgery 2024, 43:101–108

Background
Management of pilonidal disease lacks a single optimal treatment strategy, and recurrence is a problem for both the patient and the surgeon. Various flap-based treatment approaches are available for the treatment of such problems. This study aims to compare the outcome of dufourmentel flap versus conventional rhomboid in complex pilonidal diseases.
Patients and methods
The present randomized controlled study included 64 patients with complex pilonidal sinus, who were randomly divided into two groups: group A (n=32) patients underwent a dufourmentel flap while group B (n=32) patients underwent conventional rhomboid (Limberg flap). Follow-up was planned for early postoperative complications and recurrence as well as the aesthetic outcome.
Results
The mean age was 25.3±7.4 and 25.8±5.8.years in groups A and B, respectively. There was a statistically significant longer flap in group A when compared with group B (P=0.04). The mean operative time was 39.3±4.8 and 43±4.4 in groups A and B, respectively. Postoperative follow-up revealed a higher rate of complications in group B than in group A with a statistically significant difference in postoperative infection/discharge, hematoma, seroma, and partial flap loss.
Conclusion
Due to its adaptability, repeatability, clear, and predictable closure of the defect, and low recurrence rate, the authors suggest the dufourmentel flap as a suitable approach in the treatment of difficult and recurrent cases.

Keywords:
dufourmentel flap, Limberg flap, pilonidal

Egyptian J Surgery 43:101–108

1110-1121

Introduction

Pilonidal disease (PD), a prevalent condition affecting young adults, has a frequency of about 25/100.000 and affects men more commonly than women [1].

Excision of the diseased tissue is the standard treatment for complex and recurrent cases with or without primary closure (including various flap techniques). Excision with primary closure has a significant healing rate than healing by secondary intention [2].

In addition, regardless of the manner of closure, individuals who underwent excision with healing by secondary intention took more time off from work than those who underwent excision with primary closure. This is probably a result of less pain and a reduced need for ongoing care with open wounds, in addition to faster healing [3].

A treatment plan for recurrent cases should aim to help the patient return to their routine as soon as possible. The removal of all potentially infectious areas, the covering of the defect with healthy, well-vascularized, and the prevention of recurrence are the three most crucial factors for PD surgery [2]. PD may cause melancholy, low self-esteem, and absence from work [4].

Primary midline closure is linked to a considerably high recurrence of 8.7% as the 2010 Cochrane systematic review showed [5].

There have been several flap procedures documented; however it is outside the scope of this study to discuss them in depth. The Limberg flap and the duoformentel flap, which combine rotation of a lipocutaneous flap with closure that flattens the gluteal cleft and excises all

of the affected skin and sinuses to varying depths, are frequently used to treat refractory PD [6].

With the help of multiple randomized trials, the Limberg flap is described as an off-midline treatment to treat pilonidal illness. In its original configuration, the Limberg flap causes the natal cleft and the wound to intersect, which is a common location for nonhealing wound dehiscence [7].

In contrast to the Limberg flap, the dufourmentel flap enables the repair of rhombus-shaped lesions with any combination of internal angles. The dufourmentel flap is a highly adaptable and patient-specific procedure. It benefits from a smaller pivot region, which results in a smaller standing cutaneous deformity [8].

There are several relatively recent randomized trials that either show equivalency between different flap procedures or the benefit of one flap over another [9].

The authors were inspired to perform this analysis by the uncertainty around the dufourmentel or the Limberg flap as the most effective treatment for complex pilonidal illness.

Patients and methods

Study design and patients

The current prospective randomized controlled study was conducted at the General Surgery Department, Benha University Hospital and Al-Ahrar Teaching Hospital throughout the period from January 2022 till October 2023 after approval of ethics and research committees, Benha University and in accordance with the Code of Ethics of the World Medical Association Declaration of Helsinki.

The study included 64 patients with complex pilonidal sinus including recurrent, those with multiple openings, or cases presented after pilonidal abscess drainage. Eligible patients were randomly divided into two groups. Group A (n=32) underwent a dufourmentel flap, while group B (n=32) underwent the rhomboid (Limberg flap) flap. Exclusion criteria included patients with simple pilonidal sinus or those with an American Society of Anesthesiologists score of more than 3 or who refused to be included in the study.

A written informed consent will be obtained from all included patients.

The staging was done using a proposed scoring system by Guner *et al.* [10] into the following:

(1) Stage I: one midline pit, no lateral extension.
(2) Stage IIa: two to three midline pits.
(3) Stage IIb: more than three midline.
(4) Stage III: midline pit/pits with one lateral direction extension.
(5) Stage IV: midline pit/pits plus with both lateral direction extensions.
(6) Stage R: recurrent cases.

Randomization: it was done by specific software (Random Allocation Software 1.0, 2011, M. shaghaei, Isfhan, Iran).

Procedures

After history taking, examination, and investigations, both procedures were done under spinal anesthesia.

Group A: patients underwent dufourmentel flap

The lines of the incision were marked. Two lines were drawn to design the flap. The first line extends the defect's short diagonal, and the second line extends one of the defect's sides. The first side of the flap, which is equal in length to the sides of the defect, is formed by bisecting the angle formed by these two lines and a third line. The second flap side is drawn parallel to the defect's long diagonal and is the same length as the defect's sides (Fig. 1a,b). Then each sinus pit was injected with methylene blue.

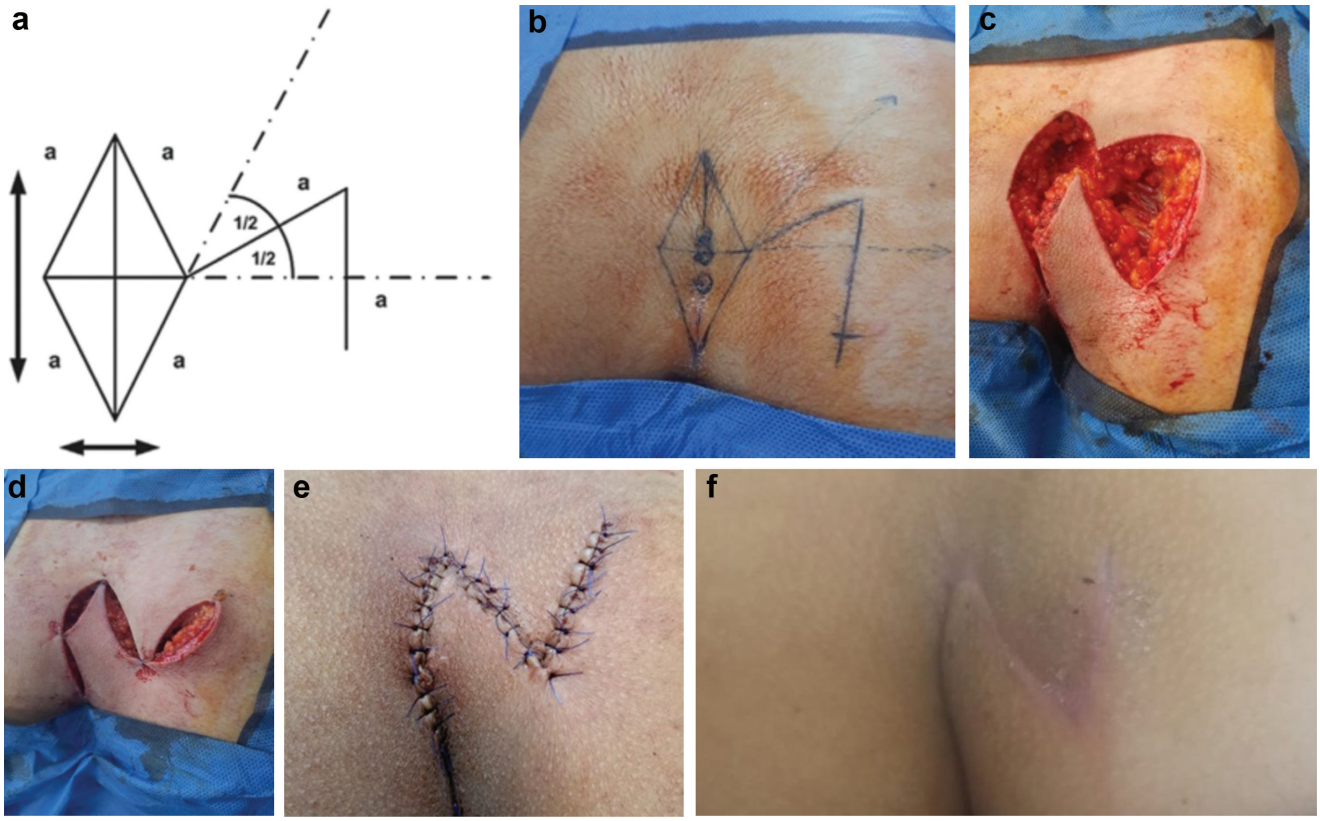
Removal of all the infected tissue is done followed by dissection including the fascia of the gluteus maximus till complete mobilization of the flap (Fig. 1c) and then transposition and insetting of the flap was done (Fig. 1d). Subcutaneous tissue of the flap was sutured to the gluteus maximus fascia with separate stitches of polyglactin-0. Resorbable 3-0 polyglactin sutures were used for the closure of the subcutaneous tissue over the suction drain, and nonresorbable interrupted 4-0 sutures (Fig. 1e) were used for skin closure [1].

Group B: patients underwent Limberg flap

For reconstruction, the Limberg flap was applied to this group.

A rhombus was drawn up in the gluteal region following the classical lap design (Fig. 2a,b), covering all of the apparent lesions and descending as far as the presacral fascia before being eliminated (Fig. 2c). After thorough hemostasis, a broad-pedicle, full-thickness flap containing the gluteus maximus fascia was created (Fig. 2d). The presacral fascia defect was subsequently covered with the flap. Polyglactin 3-0 was used to stitch the flap's

Figure 1



Dufourmentel flap. (a) Flap design (b) Flap design. (c) Excision of the sinus and flap mobilization. (d) Flap insetting. (e) Suturing of the flap. (f) Final aesthetic outcome.

subcutaneous tissue together. The skin was closed with nonresorbable interrupted 4-0 sutures and a subcutaneous over-suction drain [11].

In both groups, postoperative care included:

There were no restrictions placed on the patient's activity or resting position following surgery. On the first postoperative day, all patients were mobilized, and they were all discharged with proper wound care instructions. Ten days after the procedure, skin sutures were removed. Then, at 1, 3, and 12 months patients were clinically followed upon.

After a week following surgery, follow-up visits were planned, and they continued every 2 weeks until full recovery. Complications were reported.

Outcomes

The primary outcome is successful excision of the pilonidal sinus with closure of the defect using one of the two flaps with minimal postoperative complications.

The secondary outcome is the accepted final aesthetic (Fig. 1f and Fig. 2e) results that were assessed through the Vancouver scar scale. The assessment of patient satisfaction was done by Likert scale [12] using a five-point score (1=excellent, 2=good, 3=fair, 4=poor, and 5=bad). The aesthetic outcome was obtained by assessment of the final scar appearance by three independent plastic surgeons using Vancouver's scar scale [13], which assesses the scar according to four main categories: vascularity, pliability, pigmentation, and height (Table 1). The total score ranges between 0 (normal skin) and 13 (the worst imaginable scar).

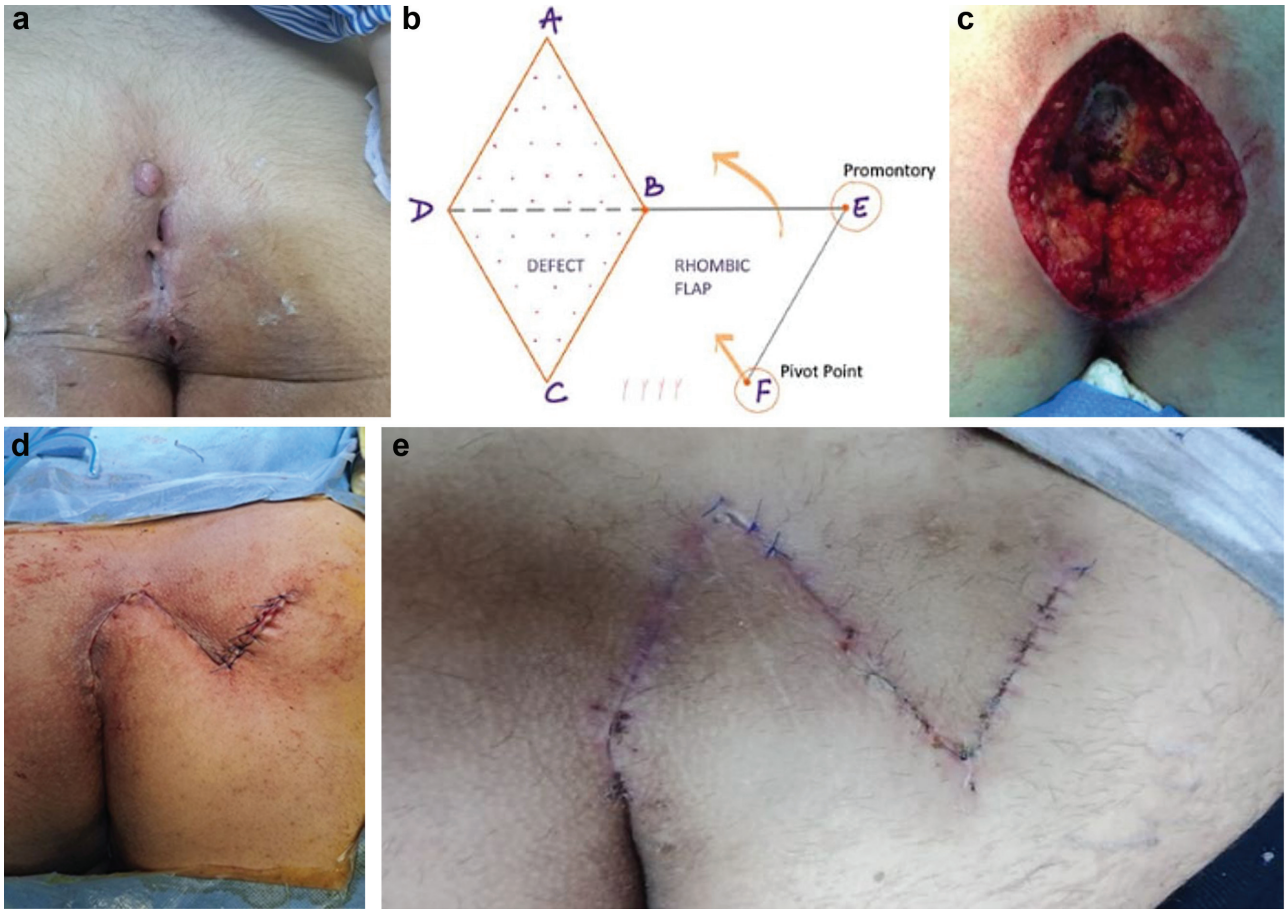
Statistical analysis

Sample size

The sample size was calculated depending on the incidence of postoperative complications, which is the primary outcome with the incidence of 10% loss in follow up. A sample size of 32 in each group was considered with a power of 80%, *P* value of 0.05, and an effect size of 0.7 using G*power 3.1 software (Universities, Dusseldorf, Germany).

SPSS, version 25 (IBM Corp., Armonk, New York, USA) was used for statistical analysis. Student's *t* test was used for quantitative parameters that were described using mean and SD. The χ^2 test was used

Figure 2



Limberg flap. (a) Complex PD. (b) Flap design. (c) Excision of the sinus. (d) Flap insetting and closure of the wound. (e) Final aesthetic outcome.

Table 1 Vancouver scar scale [13]

Scar characteristic	Score
Vascularity	
Normal	0
Pink	1
Red	2
Purple	3
Pigmentation	
Normal	0
Hypopigmentation	1
Hyperpigmentation	2
Pliability	
Normal	0
Supple	1
Yielding	2
Firm	3
Ropes	4
Contracture	5
Height (mm)	
Flat	0
<2	1
2	2
>5	3
Total score	13

for qualitative parameters that were described as the frequency with percent. *P* values of less than 0.05 were considered significant.

Rank correlation coefficient (*r*) was used to measure Pearson's linear correlation between quantitative variables, namely, Vancouver's scar scale and patient satisfaction.

Results

The present randomized controlled study included 64 patients with complex PD. The mean age was 25.3±7.4 and 25.8±5.8 years in groups A and B, respectively (Table 2). There was no statistically significant difference between both groups regarding the sociodemographic data or comorbidities (Table 1).

Preoperative duration in the dufourmentel group ranged from 6 to 96 months, while in the conventional rhomboid group it ranged from 6 to 84 months without any statistically significant difference. There was no statistically significant difference

Table 2 Comparison of demographic data, comorbidities, and clinical presentations between the studied groups

	Group A: dufourmentel flap	Group B: conventional rhomboid	*P* value
Age (years) (mean±SD)	25.3±7.4	25.8±5.8	0.87
BMI (kg/m^2) (mean±SD)	26±2.4	25.3±2.5	0.84
Sex [*n* (%)]			
Female	10 (31.3)	11 (34.4)	0.58
Male	22 (68.7)	21 (65.6)	
Comorbidity [*n* (%)]			
DM	3 (9.4)	3 (9.4)	0.27
Smoking	7 (21.9)	9 (28.1)	0.54
Preoperative duration (years) (mean±SD)	2.54±1.76	2.73±1.97	0.61
Clinical presentation [*n* (%)]			
Recurrent attacks	9 (28.1)	11 (34.37)	0.891
Continuous pain	17 (53.15)	14 (43.75)	0.612
Continuous discharge	6 (18.75)	7 (21.88)	0.923
Stage of SPND [*n* (%)]			
III	14 (43.75)	14 (43.75)	
IV	16 (50)	15 (46.88)	0.36
R	2 (6.25)	3 (9.37)	

between the studied group with regard to local examination data (Table 2).

The mean operative time was 39.3±4.8 and 43±4.4 in groups A and B, respectively. There was a statistically significant longer flap in group A when compared with group B (P=0.04), while there was no statistically significant difference among both groups regarding the width of the flap (Table 3).

There was no significant difference between the studied groups as regards visual analog scale pain score immediately postoperatively on the first day and after 1 week from the operation. Postoperative follow-up showed a higher rate of complications in group B than in group A with a statistically significant difference in postoperative infection/discharge, hematoma, seroma, and partial flap loss. No cases of recurrence were reported after 12 months of follow-up in both groups (Table 3).

There was no statistically significant difference between both groups regarding patient satisfaction and aesthetic outcome. There was a strong positive correlation between patients' evaluation and independent surgeons' assessment (r=0.91 and 0.87) in groups A and B, respectively (Table 4).

Discussion

The management of PD lacks a single optimal treatment strategy. Recurrence of PD will continue to be a problem for both the patient and the surgeon [2]. Various flap-based treatment approaches aim to remove the disease while also providing healthy tissue coverage for the defect left behind by extensive excision

Table 3 Comparison of operative data, flap dimensions, postoperative follow-up, and complications between the studied groups

	Group A: dufourmentel flap	Group B: conventional rhomboid	*P* value
Operation time(min) (mean±SD)	39.3±4.8	43±4.4	0.77
AB flap length (mm) (mean±SD)	55±12.1	41.8±12.9	0.04*
BC flap length (mm) (mean±SD)	40.2±11.3	45.3±12.1	0.07
Immediately postoperative (mean±SD)	8.3±1.2	8.5±1.4	0.66
1st day postoperative (mean±SD)	6.4±1.1	6.7±1	0.9
1-week postoperative (mean±SD)	2±0.7	2.1±0.6	0.4
Infection/discharge [*n* (%)]	2 (6.3)	4 (12.5)	0.03*
Hematoma [*n* (%)]	1 (3.1)	2 (6.3)	0.046*
Seroma [*n* (%)]	2 (6.3)	4 (12.5)	0.02*
Pain [*n* (%)]	4 (12.5)	5 (15.6)	0.77
Itching [*n* (%)]	2 (6.3)	3 (9.4)	0.68
Partial flap loss [*n* (%)]	0	2(6.3)	0.01*
Recurrence after 1 year [*n* (%)]	0	0	1.00

*Statistically significant.

Table 4 Patient satisfaction and independent investigator assessment

	Group A: dufourmentel flap	Group B: conventional rhomboid	*P* value
Patient satisfaction [*n* (%)]			
Excellent	9 (28.12)	8 (25)	0.78
Good	4 (12.5)	5 (15.62)	0.23
Fair	17 (53.12)	16 (50)	0.65
Poor	2 (6.76)	3 (9.38)	0.61
Physician evaluation			
Range	1–7	1–8	
Mean±SD	2.66±1.12	2.87±1.2	0.12
	r=0.91	*r*=0.87	

to change the shape of the natal cleft to lessen the likelihood of the disease recurring [14].

Regarding the mean operative time, which was 39.34.8 and 434.4 min in patients who underwent dufourmentel flap and Limberg flap, respectively, in the current study, there was no statistically significant difference between the two groups. This was consistent with the findings of Lieto *et al.* [15] and Yildar *et al.* [16], who reported nearly the same mean operative time. It is believed that the fact that many patients with simple pilonidal sinus were included in the Ekici *et al.* [17] study, which indicated a reduced surgical time of 34.6 min in patients treated with Limberg flap, is the cause of this finding.

Randomized research comparing a dufourmentel flap to a traditional rhomboid flap in solely recurrent patients showed that the dufourmentel flap resulted in a reduced wound infection rate, a lower recurrence rate, a shorter hospital stay, and a quicker return to work [18].

The relatively wider defect that results from the Limberg flap can be attributed to this higher seroma and wound infection rate in the current study's patients compared with those who underwent the duofourmentel flap. This is consistent with the findings of Alptekin *et al.* [19], who discovered that the size of the excised specimen in PD procedures correlates with surgical site infection.

In their study, Ekici *et al.* [17] reported an incidence of seroma of eight (7%) in patients who underwent the dufourmentel flap operation, which is consistent with the present findings. In contrast, Akin *et al.* [20] observed a lower incidence of seroma in patients treated with the dufourmentel flap technique, which was 2.91%. This finding is easily explained by the inclusion of more straightforward cases in their study, which resulted in fewer defects being left after the pilonidal sinus was excised.

Similar to the Sebastian *et al.* [1] report of 5.4% of patients with wound discharge and infection in patients who received the dufourmentel flap, the current study found a 6.3% infection rate in patients treated with the dufourmentel flap and a 12.5% infection rate in the Limberg flap group.

According to Tardu *et al.* [21] in comparison to the Limberg flap technique, the dufourmentel flap technique had lower infection rates. Partial flap loss was recorded in 6.3% of patients treated with Limberg flaps, while no occurrences of flap necrosis were reported in patients treated with dufourmentel flap surgeries, which is consistent with the Yildar *et al.* [16] findings. In addition, no occurrences of flap necrosis or flap loss in patients who underwent Limberg flap surgery were described by Sinnott and Glickman [22].

Approximately18% of patients who underwent the duoformentl flap surgery by Lieto *et al.* [15] developed recurrence sinuses. All of the procedures went smoothly; no flap necrosis happened; 33 (10.6%) patients had wound problems; and seven (2.3%) patients experienced recurrence. After a year of follow-up, the current study showed no recurring cases in either group, which may be related to the very brief follow-up period.

Overall, the results are encouraging in terms of patient tolerance and illness recurrence (0–6%). This surgical approach has some potential drawbacks, such as a significant area of tissue mobilization, an elevated risk of hematoma/seroma formation, and wound dehiscence [23].

A recent randomized controlled research shows a relatively high rate of wound dehiscence connected to the Limberg flap, despite data from previous randomized studies finding low (0–6%) overall rates of surgical site infections [24,25]. Even though the majority of these dehiscences healed completely without recurring and many of them were mild, they nevertheless need continuous wound care.

The cosmetic outcomes are the only drawbacks of this approach. However, taking into account the disease's location, primary purpose of wound healing, and an early return to full activities this procedure is sucsessful [26].

With a strong correlation between patient and independent investigator assessment in both groups, there was no statistically significant difference in patient satisfaction in the current investigation.

In a research by Altintoprak *et al.* [27], 12.6% of participants reported being unsatisfied with the duofourmentel flap's cosmetic outcomes. Two (5.4%) patients in the current study group were unhappy with the cosmetic outcomes of the procedure, but for all the patients, speedy recovery and return to normal activities were most crucial.

The duofourmentel flap's only drawback is that it cannot be used when the sinus entrance is low and close to the anus, and a considerable portion of healthy tissue would be removed needlessly [1]. As the midline is typically where the lowest portion of the PD area is located and must be properly excised, any techniques that move the rhombic excision to the side run the risk of leaving some infected tissue behind and causing a recurrence [28].

A prior history of PD surgery and a greater distance (>2 cm) of the lateral orifices from the midline were discovered to be independent predictors of postoperative problems by Milone *et al.* [29]. In these cases, they advised off-midline surgery.

When undertaking primary repair, the one rule that seems to benefit patients is to close the incision off-midline rather than directly midline. Faster healing times, reduced rates of wound morbidity, and decreased recurrence rates have all been routinely seen as a result [30].

Petersen *et al.* [31] reported that off-midline closure is superior to midline closure in terms of suture line breakage, dehiscence, and recurrence in a review of 10 000 patients and 74 trials. In comparison to the midline-closure group, the Limberg and dufourmentel groups had better outcomes.

Conclusion

Due to its adaptability, repeatability, clear and predictable closure of the defect, and low recurrence rate, the authors suggest the dufourmentel flap as the most suitable approach in the treatment of difficult and recurrent cases. Young patients returning to their regular jobs and sporting activities is extremely fulfilling, and this should be the major objective of PD treatment.

Acknowledgments

Authors contribution: Emad M. Abdelrahman: concept and designed the study, conducted the procedure, analyzed data, and drafted the manuscript. Elsayed O. Kilany: study design, conducted the procedure, and supervised cognitive and behavioral assessments. Ahmed A. Shoulah: collected the data and conducted the procedure, did the drafting and final revision. Amal H. Ghazy: concept and designed the study, and conducted the procedure. Sherif A. Elgazzar: collected the data, and conducted the procedure, did the drafting and final revision.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1 Sebastian M, Sroczyński M, Rudnicki J. The dufourmentel modification of the limberg flap: does it fit all? Adv Clin Exp Med 2017; 26:63–67.

2 Johnson EK, Vogel JD, Cowan ML, Feingold DL, Steele SR. Clinical Practice Guidelines Committee of the American Society of Colon and Rectal Surgeons. The American Society of Colon and Rectal Surgeons' Clinical Practice Guidelines for the Management of Pilonidal Disease. Dis Colon Rectum 2019; 62:146–157.

3 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.

4 Enriquez-Navascues JM, Emparanza JI, Alkorta M, Placer C. Metaanalysis of randomized controlled trials comparing different techniques with primary closure for chronic pilonidal sinus. Tech Coloproctol 2014; 18:863–872.

5 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; 1:CD006213.

6 Sevinç B, Karahan Ö, Okuş A, Ay S, Aksoy N, Şimşek G. Randomized prospective comparison of midline and off-midline closure techniques in pilonidal sinus surgery. Surgery 2016; 159:749–754.

7 Lesalnieks I, Ommer A, Herold A, Doll D. German National Guideline on the management of pilonidal disease: update 2020. Langenbecks Arch Surg 2021; 406:2569–2580.

8 Park SS, Little S. Rhombic flaps. In: Baker SR, editor. Local flaps in facial reconstruction. Philadelphia: Elsevier Saunders 2014; 210–230.

9 Saydam M, Ozturk B, Sinan H, Balta AZ, Demir P, Ozer MT, *et al.* Comparison of modified Limberg flap transposition and lateral advancement flap transposition with Burow's triangle in the treatment of pilonidal sinus disease. Am J Surg 2015; 210:772–777.

10 Guner A, Cekic AB, Boz A, Turkyilmaz S, Kucuktulu U. A proposed staging system for chronic symptomatic pilonidal sinus disease and results in patients treated with stage-based approach. BMC Surg 2016; 16:18.

11 Aithal SK, Rajan CS, Reddy N. Limberg flap for sacrococcygeal pilonidal sinus a safe and sound procedure. Indian J Surg 2013; 75:298–301.

12 Sullivan GM, Artino ARJr. Analyzing and interpreting data from likert-type scales. J Grad Med Educ 2013; 5:541–542.

13 Abdelrahman E, Shoulah A, Ghazal S, Nchoukati M, Balbaa M. Cheek advancement flap for nasal reconstruction following surgical excision of basal cell carcinoma: early outcome and patient satisfaction. Egypt J Surg 2021; 40:322–329.

14 Bascom J, Bascom T. Utility of the cleft lift procedure in refractory pilonidal disease. Am J Surg 2007; 193:606–609.

15 Lieto E, Castellano P, Pinto M, Zamboli A, Pignatelli C, Galizia G. Dufourmentel rhomboid flap in the radical treatment of primary and recurrent sacrococcygeal pilonidal disease. Dis Colon Rectum 2010; 53:1061–1068.

16 Yildar M, Cavdar F, Yildiz MK. The evaluation of a modified Dufourmentel flap after S-type excision for pilonidal sinus disease. Scientific World Journal 2013; 2013:459147.

17 Ekici U, Kanlıöz M, Ferhatoğlu MF, Kartal A. A comparative analysis of four different surgical methods for treatment of sacrococcygeal pilonidal sinus. Asian J Surg 2019; 42:907–913.

18 Cihan A, Ucan BH, Comert M, Cesur A, Cakmak GK, Tascilar O. Superiority of asymmetric modified Limberg flap for surgical treatment of pilonidal disease. Dis Colon Rectum 2006; 49:244–249.

19 Alptekin H, Yilmaz H, Kayis SA, Sahin M. Volume of the excised specimen and prediction of surgical site infection in pilonidal sinus procedures (surgical site infection after pilonidal sinus surgery). Surg Today 2013; 43:1365–1370.

20 Akin M, Gokbayir H, Kilic K, Topgul K, Ozdemir E, Ferahkose Z. Rhomboid excision and Limberg flap for managing pilonidal sinus: long-term results in 411 patients. Colorectal Dis 2008; 10:945–948.

21 Tardu A, Haşlak A, Özçinar B, Başak F. Comparison of Limberg flap and Dufourmentel flap methods in surgical treatment of pilonidal sinus. Turkish J Surg 2011; 27:035–040.

22 Sinnott CJ, Glickman LT. Limberg flap reconstruction for sacrococcygeal pilonidal sinus disease with and without acute abscess: Our experience and a review of the literature. Arch Plast Surg 2019; 46:235–240.

23 Käser SA, Zengaffinen R, Uhlmann M, Glaser C, Maurer CA. Primary wound closure with a Limberg flap vs. secondary wound healing after excision of a pilonidal sinus: a multicentre randomised controlled study. Int J Colorectal Dis 2015; 30:97–103.

24 Akca T, Colak T, Ustunsoy B, Kanik A, Aydin S. Randomized clinical trial comparing primary closure with the Limberg flap in the treatment of primary sacrococcygeal pilonidal disease. Br J Surg 2005; 92:1081–1084.

25 Ertan T, Koc M, Gocmen E, Aslar AK, Keskek M, Kilic M. Does technique alter quality of life after pilonidal sinus surgery?. Am J Surg 2005; 190:388–392.

26 El-Khadrawy O, Hashish M, Ismail K, Shalaby H. Outcome of the rhomboid flap for recurrent pilonidal disease. World J Surg 2009; 33:1064–1068.

27 Altintoprak F, Gundogdu K, Ergonenc T, Dikicier E, Cakmak G, Celebi F. Retrospective review of pilonidal sinus patients with early discharge after Limberg flap procedure. Int Surg 2014; 99:28–34.

28 Afşarlar CE, Yılmaz E, Karaman A, Karaman I, Ozgüner I, Erdoğan D, *et al.* Treatment of adolescent pilonidal disease with a new modification to the Limberg flap: symmetrically rotated rhomboid excision and lateralization of the Limberg flap technique. J Pediatr Surg 2013; 48:1744–1749.

29 Milone M, Di Minno MN, Bianco P, Coretti G, Musella M, Milone F. Pilonidal sinus surgery: could we predict postoperative complications?. Int Wound J 2014; 13:3.

30 Stauffer VK, Luedi MM, Kauf P, Schmid M, Diekmann M, Wieferich K, *et al.* Common surgical procedures in pilonidal sinus disease: A meta-analysis, merged data analysis, and comprehensive study on recurrence. Sci Rep 2018; 8:3058.

31 Petersen S, Koch R, Stelzner S, Wendlandt TP, Ludwig K. Primary closure techniques in chronic pilonidal sinus: A survey of the results of different surgical approaches. Dis Colon Rectum 2002; 45:1458–1467.