Al-Azhar International Medical Journal

Volume 3 | Issue 2 Article 8

2-1-2022

Comparative Study between Rhomboid Flap and De-epithelization Technique in Management of Pilonidal Sinus

Muhamed Elsayed
General surgery department faculty of medicine alazhar University cairo Egypt, mohamedfahmy271@gmail.com

Mohamed Elkordy
Surgery department faculty of medicine alazhar university cairo, kurdi95@gmail.com

Sobhy Teama
Department of surgery faculty of medicine Al azhar University Cairo, sobhyteama2007@gmail.com

How to Cite This Article

Elsayed, Muhamed; Elkordy, Mohamed; and Teama, Sobhy (2022) "Comparative Study between Rhomboid Flap and De-epithelization Technique in Management of Pilonidal Sinus," *Al-Azhar International Medical Journal*: Vol. 3: Iss. 2, Article 8.
DOI: https://doi.org/10.21608/aimj.2022.102493.1627

OPEN AIMJ ORIGINAL ARTICLE

General Surgery

Comparative Study between Rhomboid Flap and De-epithelization Technique in Management of Pilonidal Sinus

Muhamed Fahmy Elsayed Abdel Aziz [1,*] M.B.B.CH, Mohamed Mohamed Abdulrahman Elkordy [2] MD, Sobhy Rezk Ahmed Teama [2] MD

**Corresponding Author:*

Muhamed Fahmy Elsayed Abdel Aziz

mohamedfahmy271@gmail.com

Received *for publication November 09, 2021;* ***Accepted*** *February 19, 2022;* ***Published online*** *February 19, 2022.*

doi: *10.21608/aimj.2022.102493.1627*

[1]*General Surgery Department, Agouza police hospital,Cairo, Egypt.*

[2]*General Surgery Department, Faculty of Medicine, Al-Azhar University ,Cairo, Egypt.*

ABSTRACT

Background: De-epithelialization is an operative procedure that plastic and reconstructive surgeons have used effectively in mammaplasty since the 1970s. This method has been utilised in a variety of specialty fields for a variety of uncommon indications.

Aim of the work: To compare between de-epithelization technique and rhomboid flap in management of pilonidal sinus.

Patients and methods: This comparative study was carried out at Al Azhar University Hospitals' Department of General Surgery. A total of 30 patients with sacrococcygeal pilonidal sinus participated in this study.

Results: The average age of the included 30 patients (15 patients for each group) became 21.67 ± 6.03 for the de- epithelization technique and 25.13 ± 8.73 for the rhomboid flap technique, with no significant difference (p-value > 0.05) in age, gender, or BMI among the two groups.

Conclusion: In compared to the Rhomboid flap approach, the De-epithelization technique had a much shorter operating time, a significantly better functional result, and significantly shorter inpatient duration.

Keywords: *De-epithelization Technique; Rhomboid Flap; Pilonidal Sinus.*

Disclosure: *The authors have no financial interest to declare in relation to the content of this article. The Article Processing Charge was paid for by the authors.*

Authorship: *All authors have a substantial contribution to the article.*

INTRODUCTION

In 1833, Herbert Mayo published the first instance of pilonidal disease in the modern medical literature, describing a young woman with a hair-containing sinus in the sacrococcygeal area. About one and half decade later, Anderson published another case report under the title of "Hair extracted from an ulcer".[1]

In 1854, J. M. Warren described extracting a hairball from a discharging sinus in the sacrococcygeal region. He left the wound to heal by secondary intention and obtained a good result. Later in 1877, Warren more presented three similar cases and stated that he thought the condition apparently derived by the ingrowth of a hair or hairs from a single follicle.[1]

Previously described lesions did not have a name until 1880 when Hodges released the name "Pilonidal" derived from the Latin meaning literally nest (nidus) of hair (pilus) proposing a congenital theory of its origin.[1, 2]

Nowadays, the term sacrococcygeal pilonidal disease is used to describe the surgical entity describing the presence of subcutaneous infection with a characteristic epithelial track situated mostly in the upper half of the natal cleft and generally containing hair. It may present as an acute pilonidal abscess or an indolent seropurulent discharging sinus resistant to spontaneous healing.[3,6]

The aim of the work is to compare between De-epithelization technique and Rhomboid flap in management of pilonidal sinus.

PATIENTS AND METHODS

This comparative study was carried out at Al Azhar University Hospitals' Department of General Surgery. After receiving approval from the local ethical committee and obtaining fully informed written consent from the patient. This research was done on 30 patients with sacrococcygeal pilonidal sinus. The following information was collected: age, gender, presentation, number of sinus pits, midline or lateral pits, therapies, complications, hospitalization stay, and postoperative results.

All patients were randomly assigned to one of two groups: Group A comprises of 15 patients who would be treated using the de-epithelialization technique. Group B: A total of 15 patients would be treated with a rhomboid flap.

Prospectively enrolled patients had: Understand proposed investigations, treatment and signed a detailed informed consent document, as well as, latest patient information leaflet.

Patients were enrolled in the study according to the following inclusion criteria: Prepared patients with clean non- infected pilonidal sinus, may be recurrent

pilonidal sinus, Age: 16 – 50, and both sexes. While the exclusion criteria were: Patients with diseases making them un fit to surgery, infected pilonidal sinus, pregnancy and diabetic patients.

All patients undergo a preoperative workup that includes taking a history, a clinical investigation, and laboratory tests (CBC, kidney and liver functions and coagulation profile).

Preoperative care: Patients' age, sex, duration of symptoms, use of antibiotics prior to surgery, and prior therapies were all entered into a patient record form, all patients were subjected to full necessary laboratory tests before surgery. The day before surgery, all patients had been admitted to the hospital and underwent surgery under anesthesia.

Postoperative care: Drain will be installed mandatory in all patients. All patients will be followed up for 6 months. Patients were seen routinely day after day for 14 days for wound examination and suture removal. Patients with delayed healing were followed up on until they were completely healed. The duration of hospitalization, coming back to work, and complications like wound collapse and contagion, as well as wound treatment duration, have all been tracked. Patients were asked to use the numerical rating pain scale for pain and effect of analgesia after surgery. Patients also had the option to verbally rate their scale from 0 to 10 to be recorded. Patients were advised to shave intergluteal cleft and adjacent buttocks, or use epilation creams, and keep the operative area clean and dry at all times. Patients were informed to follow-up every two weeks for 6 months.

In Rhomboid flap technique:(a) Resection of the sinus tract: After separating the buttocks, a rhombus has been drawn up through the gluteal area, coating all the visible lesions and going down as far as the presacral fascia, till the rhombus is removed completely. (b) Flap design: Outside the defect, a diagonal line dividing the 120o angle has been elongated to the same length as the diagonal in neighboring tissue. Following that, a donor region which can be closed mainly without tension and results in a scar parallel to skin tension lines has been favored based on skin laxity around the defect. (c) Defect Coverage: The flap was then moved over the defect after it had been prepared. The flap has been prepared, which includes the gluteus maximus fascia, and moved onto the flaw in the presacral fascia after careful hemostasis. Separate polyglactin-0 stitches were used to suture the flap's subcutaneous tissue to the gluteus maximus fascia. The skin has been stapled closed and the subcutaneous cellular has been sutured with polyglactin-00. Finally, the resected specimen can be observed.

In De-epithelization technique: the patient has been positioned prone, with the buttocks taped apart to expose the natal cleft. For local anaesthesia, 20 mL of 2% prilocaine has been applied to the sacrococcygeal region around the operative site after skin disinfection with povidone iodine. A sterile methylene blue solution has been injected through a plastic cannula to delineate the tract. After that, a roughly 5 cm long flat intergluteal incision has been made up to the depth of the postsacral fascia. The pilonidal cyst and tract have been revealed and resected, along with the surrounding healthy fatty tissue. However, the surrounding cutaneous as well as subcutaneous tissue has been maintained. A number 10 scalpel blade was used to make an ellipsoidal intradermal incision of partial thickness, limited by the top and bottom points of the intergluteal incision, which included sinus orifices. As a result, such an ellipsoid region has been easily de-epithelialized by applying traction force to the surface with the scalpel blade at a 90° angle, a process identical to “peeling an orange”. In the cavity, a Penrose drain has been installed. The drain has been inserted into the orifice of the tract. The first sutures have been made with 0 nonabsorbable suture between the edge of the de-epithelialized skin, the presacral fascia, and the other reciprocal free edge, respectively. Following that, the de-epithelialized wound has been inverted and sutured with 3/0 nonabsorbable sutures to induce reciprocal overlapping. Eventually, nonabsorbable 3/0 sutures have been used to close the wound. Inverting de-epithelialized skin has been used to fill the cavity of the pilonidal cyst that's been excised.

Statistical analysis and data interpretation: The IBM SPSS software package version 26 has been used to analyse the data that's been fed into the computer. Numbers and percentages are being used to describe qualitative data. The median (min and max) as well as the mean and standard deviation are being used to describe quantitative data.

Data analysis: In 2*2 tables, the Chi-Square test has been used to compare two or more groups, while the Fischer Exact test has been used to correct the Chi-Square test when more than 25% of the cells have counted less than 5. To compare 2 independent groups, a student t-test is being used. To compare 2 independent groups, the Mann-Whitney U test is being used. The outcomes of significance tests are expressed as two-tailed probabilities. The level of significance has been tested for all of the above-mentioned tests, which has been represented as the probability of (p-value), and the outcomes have been explained as follows: If the p value is greater than 0.05, it is non-significant; if the p value is less than or equal to 0.05, it is significant; and if the p value is less than 0.001, it is highly significant.

RESULTS

Items	De Epithelization technique n= 15	Rhomboid flap n= 15	Test of significance
Age (Years)	21.67 ± 6.03	25.13 ± 8.73	t = -1.265 P= 0.216
Sex			
Male	12 (80%)	10 (66.7%)	FET= 0.682
Female	3 (20%)	5 (34.2%)	P= 0.409
BMI (Kg/m^2)	25.60 ± 3.92	26.93 ± 4.10	t = -1.685 P= 0.174

P: probability.
Continuous data expressed as mean±SD
Categorical data expressed as Number (%)
t: independent samples t-test χ2: Chi-square test
*: significant value < 0.05

Table 1: Analysis of demographic data in the two study groups

Items	De Epithelization technique n= 15	Rhomboid flap n= 15	Test of significance
	Complaint		
Discharge	13 (86.7%)	12 (80%)	FET= 1.373
Pain	0 (0%)	2 (13.3%)	P= 0.305
Pruiritis	2 (13.3%)	1 (6.7%)	
Duration of complaint (Months)	14.20 ± 4.91	16.93 ± 5.23	t = -2.404 P= 0.095

P: probability.
Categorical data expressed as Number (%)
t: independent samples t-test χ2: Chi-square test

Table 1: Analysis of complaint and duration of complaint in the two study groups

The average age of the included 30 patients (15 patients for each group) became 21.67 ± 6.03 for the de- epithelization technique and 25.13 ± 8.73 for the rhomboid flap technique, with no significant difference (p-value > 0.05) in age, gender, or BMI among the two groups.The detailed demographic data is explained in Table 3.

Items	De Epithelization technique n= 15	Rhomboid flap n= 15	Test of significance
Number of openings	2 (1-7)	2 (1-4)	z = -1.031 P= 0.302
Clinical staging			
Stage 1	3 (20%)	1 (6.7%)	FET= 2.119
Stage 2	6 (40%)	8 (63.3%)	P= 0.225
Stage 3	2 (13.3%)	1 (6.7%)	
Stage 4	1 (6.7%)	0 (0%)	
Stage R	3 (20%)	5 (33.3%)	
Previous abscess drainage	3 (20%)	4 (26.7%)	FET = 0.186 P= 0.752

P: probability.
Continuous data expressed as mean±SD
Categorical data expressed as Number (%)
t: independent samples t-test χ2: Chi-square test
*: significant value < 0.05

Table 2: Analysis of clinical examination in the two study groups

Regarding the main complaint of both groups, discharge was the most frequent one, with an incidence percent 86.7 and 80 for De-epithelization technique and Rhomboid flap respectively. There was no significant difference in the duration of symptoms between the two groups (p-value > 0.05).

Regarding the clinical examination of both groups, the mean number of openings was 2 for both De-epithelization technique group (range 1:7) and Rhomboid flap (range 1:4), and regarding the clinical staging, stage 2 was the most frequent. In terms of the clinical examination, there was no statistically significant difference (p-value > 0.05) between the two groups.

There was a significant difference (p-value < 0.05) between both groups regarding the operative time with shortest time for De-epithelization technique.

There was a significant difference (p-value < 0.05) between both groups regarding the hospitalization with the longest time for Rhomboid flap technique; there was no significant difference in post-operative complications (p-value > 0.05).

There was a significant difference (p-value < 0.05) between both groups regarding the post operative pain according to VAS scale with highest scores for Rhomboid flap technique.

There was a significant difference (p-value < 0.05) between both groups regarding the duration for sutures removal and return to work with longest time for Rhomboid flap technique. Moreover, there was no significant difference regarding the recurrence rate or scar appearance

Items	De Epithelization technique n= 15	Rhomboid flap n= 15	Test of significance
Operative time (Minutes)	31.40 ± 5.38	42.33 ± 6.11	t = 3.887 P= 0.015*

P: probability.
Continuous data expressed as mean±SD
Categorical data expressed as Number (%)
t: independent samples t-test χ2: Chi-square test
*: significant value < 0.05

Table 3: Analysis of operative time in the two study groups

Items	De Epithelization technique n= 15	Rhomboid flap n= 15	Test of significance
Hospitalization in days	2 (1-3)	3 (2-4)	z = -3.354 P= 0.001*
Immediate postoperative complications			
No complications	11 (73.3%)	13 (86.7%)	FET= 2.119 P= 0.225
Bleeding	1 (6.7%)	0 (0%)	
Constipation	1 (6.7%)	1 (6.7%)	
Urine retention	2 (13.3%)	1 (6.7%)	
Drain amount (cc)	886.67 ± 180.74	826.67 ± 182.12	t = 1.332 P= 0.261
Drain removal (days)	18.13 ± 5.77	15.4 ± 3.18	t = 1.607 P= 0.119
Return to daily activities (weeks)	2 (1-3)	2 (2-3)	z = -1.254 P= 0.318

P: probability.
Continuous data expressed as mean±SD
Categorical data expressed as Number (%)
t: independent samples t-test χ2: Chi-square test
*: significant value < 0.05

Table 4: Analysis of early postoperative data in the two study groups

Items	De Epithelization technique n= 15	Rhomboid flap n= 15	Test of significance
Wound dehiscence	2 (13.3%)	1 (6.7%)	FET = 0.370 P= 0.543
Numbness and hypothesia	1 (6.7%)	3 (20%)	FET = 1.154 P= 0.283
Seroma formation	0 (0%)	2 (13.3%)	FET = 1.985 P= 0.108
Infection	2 (13.3%)	2 (13.3%)	χ2= 0 P= 1

P: probability.
Continuous data expressed as mean±SD
Categorical data expressed as Number (%)
t: independent samples t-test χ2: Chi-square test
*: significant value < 0.05

Table 5: Analysis of postoperative complications in the two study groups

Items	De Epithelization technique n= 15	Rhomboid flap n= 15	Test of significance
Pain at the first day	6 (4-8)	8 (6-9)	z = -2.495 P= 0.013*
Pain at the 4th day	2 (1-5)	4 (3-6)	z = -2.989 P= 0.003*
Pain at stich removal	1 (1-3)	2 (1-3)	z = -2.436 P= 0.015*

day of pain free walking	4 (3-8)	8 (6-11)	z = -4.378 P< 0.001*
day of pain free sitting	6 (5-10)	9 (6-10)	z = -3.751 P< 0.001*

P: probability.
Continuous data expressed as mean±SD
Categorical data expressed as Number (%)
t: independent samples t-test χ2: Chi-square test
*: significant value < 0.05

Table 6: Analysis of postoperative pain in the two study groups

Items	De Epithelization technique n= 15	Rhomboid flap n= 15	Test of significance
Suture removal in days	16.33 ± 1.91	18.67 ± 1.23	t = -3.967 P= 0.001*
Days to return to work	16.93 ± 2.74	21.13 ± 2.77	t = -4.174 P < 0.001*
Recurrence	0 (0%)	0 (0%)	FET= 0 P= 1
Scar			
Fine linear	13 (86.7%)	13 (86.7%)	FET= 2.416 P= 0.186
Hypertrophic	2 (13.3%)	0 (0%)	
Keloid	0 (0%)	2 (13.3%)	
Cosmetic satisfaction score	7 (2-9)	6 (1-8)	z = -1.175 P= 0.140

P: probability.
Continuous data expressed as mean±SD
Categorical data expressed as Number (%)
t: independent samples t-test χ2: Chi-square test
*: significant value < 0.05.

Table 7: Analysis of delayed postoperative data in the two study groups

DISCUSSION

Many surgical techniques were used to treat the pilonidal sinus (PNS), which is still debatable. Nevertheless, the risks of problems and recurrence vary, and no one method has been recommended. For many years, different surgical procedures have been compared. Practical surgical methods, shorter hospital stays, quick recovery, fewer postsurgical problems and discomfort, and reduced recurrence rates are the primary elements to consider while developing an optimum treatment process [7].

In all methods (primary closing or flap), a cavity has been generated after the resection of the pilonidal cyst and surrounding healthy tissue; this must be filled or shuttered, or else it induces a technical issue that is common and could lead to problems like "dead space," hematoma, infection of the wound, as well as separation of the wound throughout the early postsurgical period [8].

The complexity of wound healing is the most significant disadvantage. In the late phase, hypoesthesia as well as cosmetic issues in the sacrococcygeal area have been found, especially after flap surgery [9]. De-epithelization technique in mammaplasty is generally performed by aesthetic surgeons. The cutaneous flap and fatty tissue have been reversed after the cutaneous tissue has been removed to generate the breast protrusion in this procedure. Skin grafts that have been de-epithelialized have been utilized in a variety of procedures [10]. The goal of this research is to see how the de-epithelization method compares to the rhomboid flap in the treatment of pilonidal sinus.

The average age of the de-epithelization technique became 21.67 ± 6.03 and 25.13 ± 8.73 for the rhomboid flap technique among the 30 patients included in our study (15 patients for each group), with no significant difference in age, gender, or BMI among the two groups (p-value > 0.05).

Regarding the main complaint in our study of both groups, discharge was the most frequent one, with an incidence percent 86.7 and 80 for De Epithelization technique and Rhomboid flap respectively. There was no significant difference in the duration of symptoms between the two groups (p-value > 0.05).

De-epithelialization is a surgical procedure that plastic and reconstructive surgeons have used effectively in mammaplasty since the 1970s. This method has been utilised in a variety of specialty fields for a variety of uncommon indications. After surgically removing the tumour, Yoon et al. [11] utilised this to repair oral and/or oropharyngeal abnormalities. Lee et al. [10] used a wound-margin de-epithelialized cutaneous graft to repair finger deformities with exposed tendon or bone.

Balat et al. [12] found that treating vulvar cancer with a de-epithelialized rhomboid flap resulted in an acceptable outcome. Penile restoration with a de-epithelialized Belman (superficial outer pudendal artery) flap was performed on a patient with Peyronie's illness, and the outcome was satisfactory [13]. After de-epithelization, Park et al. utilized a musculocutaneous flap of the serratus anterior to erase bronchopleural fistulas.[14].

A right ventricular rupture caused by a sternal wound infection was also repaired using a previously described

de-epithelialized myocutaneous latissimus dorsi graft [15]. Gupta et al. [16] showed that utilising a de-epithelialized flap for the additional coat of the built neourethra had been a suitable alternative for the correction of hypospadias following Snodgrass urethroplasty.

Thompson et al. [17] advocated that midline skin pits be removed without extensive excisions. Similarly, instead of cyst removal, several writers recommended curative excision of cavity epithelia with radiofrequency or phenol as a minimally invasive method[18]. Washer et al. [19] presented a considerably extra difficult flap approach (advancement of the gluteal fascia) as an ideal way to treat PNS.

The lateralization and flattening of the natal cleft are already being stated as the objective of an ideal therapy for PNS by Yildiz et al. [20] However, after a longer time of follow-up, the data will need to be reevaluated. In practise, extensive ablation with flap repair has been generally done under spinal anaesthesia, as patients must stay in the hospital for at least one night[7].

For example, in Khan et al. in a randomized clinical trial[21], the average surgical time in the excision+primary closing group was 55 minutes, and 70 minutes in the excision+Limberg flap group; Dass et al. in another randomized research study [22], for primary closure, the average surgical time has been 44 minutes. In our results, the operative time differed significantly (p-value 0.05) among the two groups, with the De Epithelization technique taking the longest time (mean= 42.33 ± 6.11 min).

Hematoma, seroma, and infection of the wound are all well-known recurrence risk factors [23]. According to Kirkil et al. [24] , the drained and non-drained Limberg flap groups had 17.8% and 29.6% complication rates, respectively. Käser et al. [25] found a 49 percent complication rate in the Limberg flap group and a 12 percent complication rate in the excision alone group. In the research of Arslan et al.[23] 30 patients treated with the Karydakis flap technique had 19.8% seroma development and 15.4% wound dehiscence. The Rhomboid flap technique had a significant difference (p-value < 0.05) between the two groups in terms of length of hospitalization, but no significant difference (p-value > 0.05) in terms of post-operative complications in our study.

Kirkil et al. [24] questioned the efficacy of cavity drainage in their trial, finding that complication rates were equal in the drained and non-drained Limberg flap groups. The authors stated that in the Limberg flap method for PSD, regular drain use had no effect on operative site problems. Käser et al. [25] observed that the Limberg flap group had an average pain score of 2.4 and the excision alone group had an average pain score of 2.5 at discharge, respectively. According to the VAS scale, there was a significant difference (p-value < 0.05) between the two groups in terms of post-operative pain, with the Rhomboid flap technique receiving the highest scores. Because of the link between higher pain VAS scores and wound tension, Dass et al. 22 reported that primary closing had been a more painful method.

CONCLUSION

In compared to the Rhomboid flap approach, the De-epithelization technique had a much shorter operating time, a significantly better functional result, and a significantly shorter inpatient duration.

REFERENCES

1. Raffman RA. A re-evaluation of the pathogenesis of pilonidal sinus. *Ann Surg*. 1959; 150:895-903.
2. Afsarlar CE, Yilmaz E, Karaman A, Karaman I, Ozguner IF, Erdogan 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(8):1744-9.
3. 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):568-73.
4. da Silva JH. Pilonidal cyst: cause and treatment. *Dis Colon Rectum*. 2000; 43(8):1146-56.
5. El-Khadrawy O, Hashish M, Ismail K, Shalaby H. Outcome of the rhomboid flap for recurrent pilonidal disease. *World J Surg*. 2009; 33(5):1064-8.
6. Khanna A, Rombeau JL. Pilonidal disease. *Clin Colon Rectal Surg*. 2011; 24(1):46-53.
7. Akan K, Tihan D, Duman U, Ozgun Y, Erol F, Polat M. Comparison of surgical Limberg flap technique and crystallized phenol application in the treatment of pilonidal sinus disease: a retrospective study. *Ulus Cerrahi Derg*. 2013;29:162–6.
8. Petersen S, Aumann G, Kramer A, Doll D, Sailer M, Hellmich G. Short- term results of Karydakis flap for pilonidal sinus disease. *Tech Coloproctol*. 2007;11:235-40.
9. Muller K, Marti L, Tarantino I, Jayne DG, Wolff K, Hetzer FH. Prospective analysis of cosmesis, morbidity, and patient satisfaction following Limberg flap for the treatment of sacrococcygeal pilonidal sinus.*Dis Colon Rectum*. 2011;54:487-94.
10. Lee JH, Burm JS, Kang SY, Yang WY. Full-thickness skin grafting with de-epithelization of the wound margin for finger defects with bone or tendon exposure. *Arch Plast Surg*. 2015;42:334–40.
11. Yoon J, Yim JH, Kim EK. Simplified Designing and Insetting of the Free Flap in Reconstructing Oral and/or Oropharyngeal Defect. J Craniofac Surg. 2015;26:2004-2007.
12. Balat O, Tercan M, Bekerecioglu M, Aydin A, Karakok M, Kutlar I. Adenoid cystic carcinoma of the vulva: conservative surgery using a de- epithelized rhomboid flap. Eur J Gynaecol Oncol. 2001;22:387–388
13. Abe S, Takami Y, Yamaguchi Y, Hata K, Yamaguchi T. Penile reconstruction with de-epithelized superficial external pudendal artery flap. *J Urol*. 1992;147:155–7.
14. Park JS, Eom JS, Choi SH, Kim YH, Kim EK. Use of a serratus anterior musculocutaneous flap for surgical obliteration of a bronchopleural fistula. *Interact Cardiovasc Thorac Surg*. 2015;20:569–74.

15. Hakala T, Berg L, Berg E, Makinen K, Sipola P. Repair of right ventricular free wall defect with a de-epithelized pedicled myocutaneous latissimus dorsi muscle flap. *Ann Thorac Surg*. 2005;80:2360–2.

16. Gupta AK, Sarda D, Kothari PR, Jiwane A, Kulkarni BK. Tubularized incised plate urethroplasty with de-epithelialized flap. *Afr J Paediatr Surg*. 2008;5:8–10.

17. Thompson MR, Senapati A, Kitchen P. Simple day-case surgery for pilonidal sinus disease. *Br J Surg*. 2011;98:198–209.

18. Dag A, Colak T, Turkmenoglu O, Sozutek A, Gundogdu R. Phenol procedure for pilonidal sinus disease and risk factors for treatment failure. *Surgery*. 2012;151:113-7.

19. Washer JD, Smith DE, Carman ME, Blackhurst DW. Gluteal fascial advancement: an innovative, effective method for treating pilonidal disease. *Am Surg*. 2010;76:154–6.

20. Yildiz MK, Ozkan E, Odabasi HM, Kaya B, Eris C, Abuoglu HH, et al. Karydakis flap procedure in patients with sacrococcygeal pilonidal sinus disease: experience of a single centre in Istanbul. *Scientific World Journal*. 2013;2013:807027.

21. Khan PS, Hayat H, Hayat G. Limberg flap versus primary closure in the treatment of primary sacrococcygeal pilonidal disease; a randomized clinical trial. *Indian J Surg.* 2013;75:192–4.

22. Dass TA, Zaz M, Rather A, Bari S. Elliptical excision with midline primary closure versus rhomboid excision with Limberg flap reconstruction in sacrococcygeal pilonidal disease: a prospective, randomized study. *Indian J Surg.* 2012;74:305–8.

23. Arslan K, Kokcam SS, Koksal H, Turan E, Atay A, Dogru O. Which flap method should be preferred for the treatment of pilonidal sinus? A prospective randomized study. *Tech Coloproctol*. 2014;18:29–37.

24. Kirkil C, Boyuk A, Bulbuller N, Aygen E, Karabulut K, Coskun S. The effects of drainage on the rates of early wound complications and recurrences after Limberg flap reconstruction in patients with pilonidal disease. *Tech Coloproctol*. 2011;15:425–9.

25. Käser S, Zengaffinen R, Uhlmann M, Glaser C, Maurer C. 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.