Pilonidal sinus in adolescence: is there an ideal surgical approach?

M. Roldón Golet[1], A. Siles Hinojosa[2], Y. González Ruiz[3], R. Escartín Villacampa[3], I. Goded Broto[1], P. Bragagnini Rodríguez[3]

[1]General and Digestive Surgery Department, San Jorge University Hospital, Huesca (Spain). [2]Pediatric Surgery Department, Regional University Hospital, Málaga (Spain). [3]Pediatric Surgery Department, Miguel Servet University Hospital, Zaragoza (Spain).

ABSTRACT

Objective. The objective of this work was to compare excision with primary closure according to Karydakis technique (KT) with en bloc resection with secondary healing (EB) in the treatment of pilonidal sinus in adolescents.

Materials and methods. An observational, retrospective, multi-center study was carried out in adolescent patients (11-18 years old) diagnosed with pilonidal sinus and undergoing surgery from 2011 to 2017. Patients were divided into 2 groups: KT (pediatric surgeons) and EB (general surgeons).

Results. Our sample consisted of 61 patients (KT: 26 patients; EB: 35 patients). Mean total recovery time (days) was significantly shorter in the KT group (37.77 KT vs. 107.76 EB, p<0.001). In terms of postoperative complications, no differences were noted regarding overall complication rate (53.8% KT vs. 40% EB). However, differences were found in postoperative bleeding (0% KT vs. 25.7% EB, p=0.005), seroma occurrence (23.1% KT vs. 0% EB, p=0.003), and surgical wound dehiscence (42.3% KT vs. 8.6% EB, p=0.002). Recurrence rate was lower in the Karydakis group than in the en bloc resection group (4% vs. 28.6%, p=0.015).

Conclusions. Both surgical techniques (KT and EB) are acceptable and safe, but in our study, Karydakis technique demonstrated to be more effective than en bloc resection with secondary closure, since it allowed for shorter recovery times and lower recurrence rates. Therefore, Karydakis surgical technique can be an excellent alternative in the treatment of pilonidal sinus in the adolescent population.

KEY WORDS: Pilonidal sinus; Adolescents; Karydakis; En bloc resection.

SINUS PILONIDAL DURANTE LA ADOLESCENCIA: ¿EXISTE EL ABORDAJE QUIRÚRGICO IDEAL?

RESUMEN

Objetivos. El objetivo de este trabajo es comparar la escisión con cierre primario según la técnica de Karydakis (TK) y la exéresis en bloque con cicatrización por segunda intención (EB), para el tratamiento del sinus pilonidal en adolescentes.

Material y métodos. Estudio observacional, retrospectivo y multicéntrico en pacientes en edad adolescente (11-18 años), con diagnóstico de sinus pilonidal e intervenidos entre 2011-2017, divididos en 2 grupos: TK (cirujanos pediátricos) y EB (cirujanos generales).

Resultados. Presentamos una muestra de 61 pacientes (TK: 26 pacientes y EB: 35 pacientes). El tiempo medio (días) de recuperación total fue significativamente más corto en el grupo TK (37,77 TK *vs* 107,76 EB; p< 0,001). En cuanto a las complicaciones postoperatorias, no se encontraron diferencias respecto a la tasa global de complicaciones (53,8% TK *vs* 40% EB). Sin embargo, se demuestran diferencias en el sangrado postquirúrgico (0% TK *vs* 25,7% EB; p= 0,005), aparición de seroma (23,1% TK *vs* 0% EB; p= 0,003) y dehiscencia de herida quirúrgica (42,3% TK *vs* 8,6% EB; p= 0,002). La tasa de recurrencia ha sido menor en el grupo de Karydakis respecto al grupo de exéresis en bloque (4% *vs* 28,6%; p= 0,015).

Conclusiones. Ambas técnicas quirúrgicas son aceptables y seguras, pero en nuestro estudio la técnica de Karydakis se ha mostrado más eficaz que la exéresis en bloque con cierre por segunda intención, ya que requiere un menor tiempo de recuperación del paciente, con una tasa de recurrencia inferior. Por ello, la técnica quirúrgica de Karydakis puede suponer una alternativa excelente en el tratamiento de la enfermedad pilonidal en población adolescente.

PALABRAS CLAVE: Sinus pilonidal; Adolescentes; Karydakis; Exéresis en bloque.

INTRODUCTION

Pilonidal sinus is a chronic inflammation of the midline of the sacrococcygeal region. Today, it has an incidence of 26 cases per 100,000 inhabitants. It mostly occurs in male adolescents[1,2].

Corresponding author: Dr. Alexander Siles Hinojosa. Pediatric Surgery Department, Regional University Hospital, Málaga (Spain).
E-mail address: alexandersileshinojosa@hotmail.com

This work was presented at the 58th Congress of the Spanish Pediatric Surgery Society held in Vigo

Date of submission: October 2020 *Date of acceptance:* March 2021

Pilonidal sinus typically starts with an acute episode of abscess in the sacrococcygeal region, which leads to significant pain and discomfort[2].

Multiple individual factors associated with the occurrence of pilonidal sinus have been described, such as male sex, young age, and overweight[3]. However, in his work, Karydakis[4] described three fundamental factors inherently related to the development of this pathology – abundant body and intergluteal hair, an external force facilitating hair insertion into the skin, and the underlying vulnerability of the skin in the intergluteal cleft. Even though the first two could be influenced and changed by personal hygiene and lifestyle, surgery is the only way to have an impact on the third.

Indeed, surgery remains the gold standard treatment, in spite of the new modalities developed in the last years (fibrin glue, laser procedures, etc.)[6,7]. Surgical procedures are increasingly simple, with shorter hospital stays, lower morbidity rates, and less postoperative care required[5,8]. As a result of this, off-midline primary closure techniques have prevailed over midline locations, with better postoperative results[5,9].

However, publications comparing resection with secondary healing – which is still in use – with off-midline closure are limited[2,10].

The objective of this work was to compare excision with primary closure according to Karydakis technique with en bloc resection with secondary healing in the treatment of pilonidal sinus in adolescents.

MATERIALS AND METHODS

A retrospective, multi-center study of patients operated on by pediatric surgeons and general surgeons was carried out. The same selection criteria were used in all cases.

Adolescent patients (11-18 years old according to international criteria) diagnosed with pilonidal sinus using pilonidal sinus clinical criteria, and undergoing surgery from January 2011 to December 2017, were included. The sample consisted of 61 patients, who were divided into two groups according to the surgical technique used – pediatric surgeons used Karydakis technique[4,10,11] (Fig. 1) (KT), and general surgeons used en bloc resection with secondary closure (EB).

Both groups were compared based on 14 variables classified as epidemiological variables, early postoperative complications, recovery time, and recurrence.

Within these variables, recurrence was defined as the formation of an abscess or a serosanguinous or purulent drainage through the incision line, or of a new fistulous orifice at any given time following complete wound healing.

Follow-up consultation time was defined as the number of days the patient spent at the specialist's consultation for check-up purposes until being discharged as a result of favorable clinical progression. Total recovery time was established as the period of time during which the patient required wound healing at a primary healthcare facility before returning to normal activity.

Statistical analysis was performed using the IBM SPSS Statistics 22.0® software. First, a descriptive analysis of the sample using relevant central tendency measures according to the type of variable studied was carried out. The association of qualitative variables was studied using the Chi-square test or Fisher's exact test, and the comparison of quantitative data was performed using Mann-Whitney U test. Statistical significance was established at $p< 0.05$. All intervals were calculated with a 95% confidence.

This study was approved by each of the healthcare facilities involved. It complies with patient data protection legislation as established by the EU General Data Protection Regulation (GDPR).

RESULTS

The sample consisted of 61 patients, who were divided into two groups according to the surgical technique used – Karydakis technique (KT) = 26 patients, and en bloc resection with secondary closure (EB) = 35 patients. Regarding sex distribution, 61.5% of patients in the Karydakis technique group were female, and 38.5% were male. However, in the en bloc resection group, 45.7% of patients were female and 54.3% were male. Mean age in the Karydakis technique group was 13.38 ± 1.17 years, and mean age in the en bloc resection group was 16.66 ± 1.16 years. In terms of weight, mean weight in the Karydakis technique group was 63.58 ± 16 kg, with a mean body mass index (BMI) of 24.79 ± 5.04, while mean weight in the en bloc resection group was 72.32 ± 13.24 kg, with a mean BMI of 23.73 ± 2.79. Weight differences were statistically significant ($p= 0.024$), but BMI differences were not ($p= 0.367$) (Table 1).

As for postoperative complications, no statistically significant differences were found in overall complication rate (53.8% KT vs. 40% EB), in the individual analysis of certain variables such as hematoma incidence (3.8% KT vs. 0% EB), or in surgical wound infection (43.1% KT vs. 56.9% EB). However, statistically significant differences were noted in terms of postoperative bleeding (0% KT vs. 25.7% EB, $p= 0.005$), seroma occurrence (23.1% KT vs. 0% EB, $p= 0.003$), and surgical wound dehiscence (42.3% KT vs. 8.6% EB, $p= 0.002$) (Table 2). Recurrence rate was lower in the Karydakis technique group than in the en bloc resection group (4% vs. 28.6%, $p= 0.015$), this difference being statistically significant, too.

Mean postoperative follow-up consultation time was shorter in the EB group (137.31 KT vs. 56.3 EB, $p< 0.05$). However, mean total recovery time was significantly shorter in the KT group (37.77 KT vs. 107.76 EB, $p< 0.001$) (Table 3).

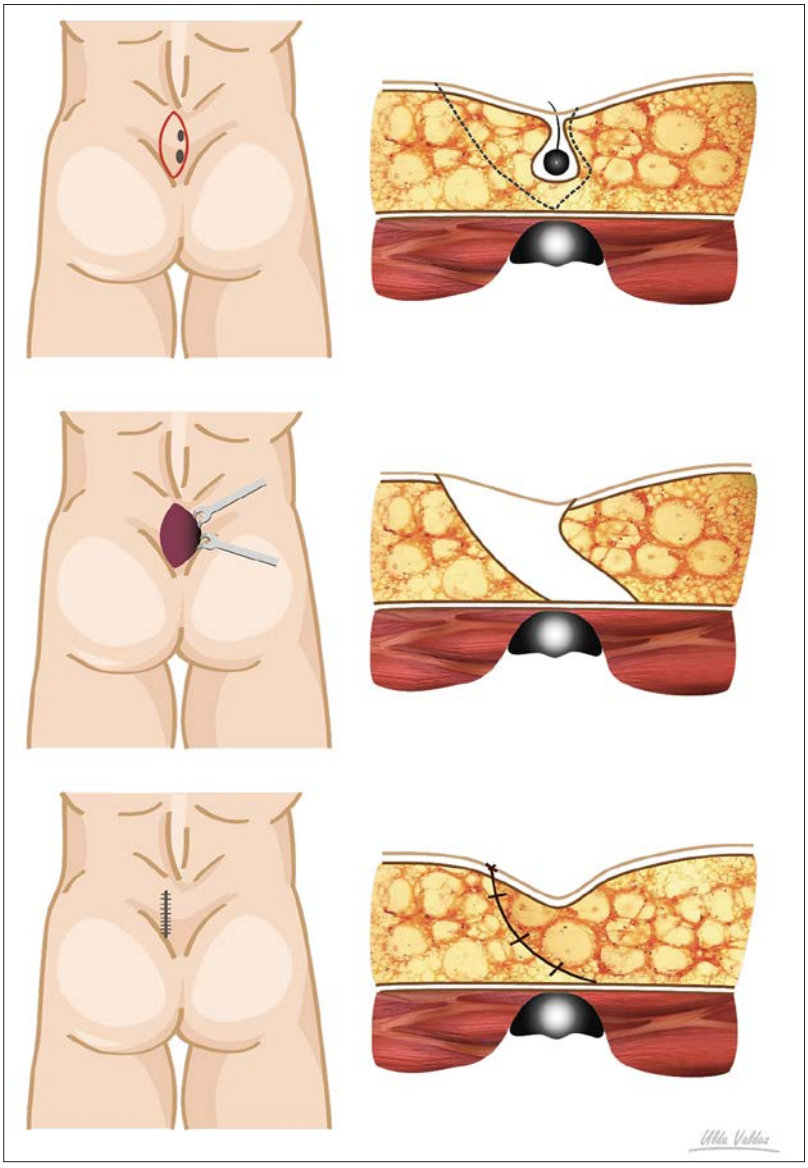

Figure 1. The surgical technique used is the classic procedure proposed by Karydakis GE[11], which involves an asymmetric resection of the damaged area by lateralizing the surgical suture, creating a flap from the medial border to cover the defect and close the wound, while avoiding the intergluteal fold.

Table 1. Epidemiological analysis.

Epidemiology	*Karydakis technique (KT) n=26*	*En bloc resection (EB) n=35*	*Statistical significance*
Sex	Female (16): 61.5% Male (10): 38.5%	Female (16): 45.7% Male (19): 54.3%	
Mean age	13.38 ± 1.17	16.66 ± 1.16	p<0.001
Mean weight	63.58 ± 16	72.32 ± 13.24	p=0.024
BMI	24.79 ± 5.04	23.73 ± 2.79	p=0.367

DISCUSSION

The surgical technique to be used in the treatment of pilonidal sinus remains one of the most controversial issues of discussion[8,9]. Multiple procedures have been developed, but none of them has prevailed as the technique of choice[3,13]. These procedures can be classified into two large groups: on the one hand, en bloc resection with secondary healing, which has traditionally been one of the most widely used procedures as it is simple and

Table 2. Postoperative complications.

Postoperative complications	*Karydakis technique (KT) n= 26*	*En bloc resection (EB) n= 35*	*Statistical significance*
Overall complication rate	14 (53.8%)	14 (40%)	p= 0.283
Seroma	6 (23.1%)	0 (0%)	p= 0.003
Hematoma	1 (3.8%)	0 (0%)	p= 0.242
Surgical wound infection	4 (15.4%)	6 (17.1%)	p= 0.854
Postoperative bleeding	0 (0%)	9 (25.7%)	p= 0.005
Surgical wound dehiscence	11 (42.3%)	3 (8.6%)	p= 0.002

Table 3. Pilonidal sinus recurrence rates and follow-up times.

	Karydakis technique (KT) n= 26	*En bloc resection (EB) n= 35*	*Statistical significance*
Recurrence	1 (4%)	10 (28.6%)	p= 0.015
Follow-up			
Mean follow-up consultation time (days)	137.31 ± 30.42	71.63 ± 9.95	p< 0.05
Mean total recovery time (days)	37.77 ± 9.35	107.76 ± 14.60	p< 0.001

safe[2,3]; and on the other hand, all new techniques based on diseased tissue excision with primary closure, which typically involve a flap[7,8].

Most recently, the latter have been gaining importance at many healthcare facilities, since they allow for quicker recovery times and have acceptable morbidity rates[6,14]. However, there are two types of closure techniques within this group – midline closure techniques, which have significant postoperative morbidity and recurrence rates as described in multiple studies[2,15], and off-midline closure techniques, which have been clearly demonstrated to be superior[9,14].

Karydakis technique[4,11], which was analyzed in this study, belongs to the last subgroup. It was described with the purpose of establishing a simple, easily reproducible procedure[16,17], with shorter recovery times and lower recurrence rates. This technique has given rise to others, such as Bascom technique, which involves a less radical resection, but does not offer better results[18,19].

The objective of this work was to compare Karydakis technique[4,11] with the traditional en bloc resection with secondary closure, since most studies today are focused on comparing off-midline closure and flap techniques with each other, or with newer techniques[20,21]. However, en bloc resection with secondary closure is still commonly performed at many healthcare facilities for the treatment of pilonidal sinus in adolescents – not just pediatric surgery institutions, but also many general surgery departments where teenagers are treated[22].

A statistical analysis of patient characteristics was carried out (Table 1), with statistically significant differences in terms of age (KT 13.38 vs. EB 16.66, p< 0.001) and weight (KT 63.58 vs. EB 72.32, p= 0.024). This may be explained by the fact patients from the en bloc resection group, who were operated on at a general surgery department, were slightly older than those undergoing Karydakis technique, which was performed at a pediatric surgery department. However, since our analysis found no statistically significant differences regarding BMI, the two patient groups can be regarded as comparable. This suggests obesity was not a risk factor for postoperative complication occurrence in this study.

As it is the case with other surgical techniques with primary closure, Karydakis technique has surgical wound related complications, such as wound infection, formation of seromas or hematomas, and wound dehiscence, which are the most frequent ones. These have been analyzed by various studies over the years, with highly inconsistent and sometimes inconclusive data[22]. In 2005, Peterson et al.[23] published a comparative study of 97 patients undergoing Karydakis technique vs. en bloc resection, with the latter having a greater proportion of postoperative complications in the first month (KT 25% vs. EB 34.8%). This is consistent with Keshvari et al.'s[2] findings following a 321-patient prospective study comparing both techniques, where overall complication rate was lower in Karydakis technique (18.7%) than in en bloc resection (31.2%). However, our results are not consistent with previous studies, since complication rate was higher in Karydakis technique than in en bloc resection (53.8% vs. 40%), the difference not being statistically significant. This translates into a higher rate of seroma (23.1% vs. 0%) and hematoma (3.8%

vs. 0%) in Karydakis technique. This inconsistency could be explained by the fact this study featured a comprehensive, breakdown analysis of all complications potentially associated with pilonidal sinus surgery.

On the other hand, surgical wound infection and postoperative bleeding rates were higher in en bloc resection. Regarding surgical wound infection, our rate in Karydakis technique (15.4%) was lower than that found in other studies such as Bali et al.'s[24] (23.4%). However, these results differ from those published by Keshvari et al.[10], where infection rate was higher in Karydakis technique (KT 5% vs. EB 0%), which implies primary tissue closure[2,10]. Such discrepancy could be due to the fact different criteria are used when it comes to defining surgical wound infection occurrence.

Wound dehiscence is another frequent complication. Techniques with primary closure are inherently associated with higher wound dehiscence rates, as it was the case in Ekici U et al.'s work[25], which compared various techniques, or in ours, with a statistically significant higher dehiscence rate in Karydakis technique. However, it should be noted that of the 11 instances of wound dehiscence, only one was total, the remaining ones being limited to a minimal partial opening of the wound. This was also described by Keshvari et al.[2], with most dehiscence instances being partial, consistent with our results.

Recurrence rate is another important factor to be considered when choosing the most adequate surgical technique[26]. In our study, recurrence rate was lower with Karydakis technique (KT 4% vs. EB 28.6%, p=0.015). In spite of being higher, these rates are consistent with those reported in other publications such as Keshvari et al.'s[2] (KT 1.2% vs. EB 7.5%) or Stauffer et al.'s meta-analysis[27], according to which Karydakis technique also has a lower recurrence rate as compared to other methods such as en bloc resection. This could be explained by the fact Karydakis technique involves a large excision, which could resect hidden pathological areas in the subcutaneous tissue, and also because the sacrococcygeal cleft is flattened, thus displacing the scar from the deep intergluteal fold[2,4,27].

In terms of follow-up consultation time, it was unsurprisingly longer in patients undergoing Karydakis technique (KT 137.31 ± 30.42 days vs. EB 71.63 ± 9.95 days), given the characteristics of the procedure and the fact it is a novel one, which requires a stricter control. However, total recovery time (KT 37.77 ± 9.35 days vs. EB 107.76 ± 9.95 days, p< 0.001) is a much more important parameter, since the patient's daily activity is greatly impacted by the presence of an open wound requiring cures and potentially a long time to heal. This is all the more important in children and adolescents, where convalescence has a deep impact on education, physical activity, and social interaction[22,28]. Therefore, based on the results achieved in this study and supported by Keshvari et al.[2,10], it can be stated that Karydakis technique has a key advantage in the treatment of pilonidal sinus in adolescents, since it allows for significantly shorter total recovery times than en bloc resection.

To sum up, treatment of pilonidal sinus with off-midline primary closure techniques has a number of advantages as compared to en bloc resection with secondary healing[27,28]. This work suggests resorting to Karydakis technique, since it is one of the most widely used within the first group and offers better results than other procedures.

However, minimally invasive surgical treatment of pilonidal sinus should be increasingly considered[29,30], since it is showing promising results. Techniques such as PEPSiT (Pediatric Endoscopic Pilonidal Sinus Treatment)[31,32] or Pit Picking[33,34] may become the new gold standard for pilonidal sinus treatment in the future, with classic techniques being limited to complex[35], advanced, or recurrent cases[36]. In spite of this, further prospective, randomized studies are required to confirm these promising initial results.

Study limitations

The small sample size of the study and its retrospective, non-randomized nature – which means there might be a selection bias – stand as a significant limitation. Another important limitation lies in the fact it is a multi-center study, which means patients were operated on by different surgical teams and healed at different healthcare facilities, potentially leading to differences in the type of healing.

CONCLUSIONS

Both surgical techniques (KT and EB) are acceptable and safe, but in our study, Karydakis technique demonstrated to be more effective than en bloc resection with secondary closure, since it allowed for shorter recovery times and lower recurrence rates. Therefore, Karydakis surgical technique can be an excellent alternative in the treatment of pilonidal sinus in the adolescent population.

REFERENCES

1. 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 meta analysis. Surgeon. 2018; 16: 315-20.
2. Keshvari A, Keramati MR, Fazeli MS, Kazemeini A, Meysamie A, Nouritaromlou MK. Karydakis flap versus excision-only technique in pilonidal disease. J Surg Res. 2015; 198: 260-6.
3. Jabbar MS, Bhutta MM, Puri N. Comparison between primary closure with limberg flap versus open procedure in treatment of pilonidal sinus, in terms of frequency of post-operative wound infection.Pakistan J Med Sci. 2018; 34: 49-53.
4. Karydakis GE. New approach to the problem of pilonidal disease. Lancet. 1973; 2: 1414-5.

5. Doll D, Luedi MM. New attempt to reach a common sense in pilonidal sinus therapy. Dis Colon Rectum. 2019; 62: 36-7.
6. Grabowski J,Oyetunji TA,Goldin AB,Baird R,Gosain A,Lal DR, et al. The management of pilonidal disease: A systematic review. J Pediatr Surg. 2019; 54: 2210-21.
7. Kallis MP, Maloney C, Lipskar AM. Management of pilonidal disease. Curr Opin Pediatr. 2018; 30: 411-6.
8. Bannura Cumsille G. ¿Cual es el tratamiento quirúrgico de elección de la enfermedad pilonidal sacrococcígea? Rev Chil Cir. 2003; 55: 92-6.
9. Braungart S, Powis M, Sutcliffe JR, Sugarman ID. Improving outcomes in pilonidal sinus disease. J Pediatr Surg. 2016; 51: 282-4.
10. Keshvari A, Keramati MR, Fazeli MS, Kazemeini A, Nouritaromlou MK. Risk factors for complications and recurrence after the Karydakis flap. J Surg Res. 2016; 204: 55-60.
11. Karydakis GE. Easy and successful treatment of pilonidal sinus after explanation of it's causative process. Aust N Z J Surg. 1992; 62: 385-9.
12. Kitchen PRB. Pilonidal sinus: experience with the Karydakis flap.Br J Surg. 1996; 83: 1452-5.
13. Hakan B, Sözen S. Disease that should be remembered: Sacrococcygeal pilonidal sinus disease and short history. World J Clin Cases. 2015; 3: 876-9.
14. Johnson EK, Vogel JD, Cowan ML, Feingold DL, Steele SR, M.D. The American Society of Colon and Rectal Surgeons' Clinical Practice Guidelines for the management of pilonidal disease. Dis Colon Rectum. 2019; 62: 146-57.
15. 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: 868-71.
16. Borel F, Gaudin C, Duchalais E, Lehur PA, Meurette G. Wound closure with Karydakis flap is decreasing the perioperative costs after pilonidal sinus excision as compared to lay-open approach. J Visc Surg. 2017; 154: 407-12.
17. Wysocki AP. Defining the learning curve for the modified Karydakis flap. Tech Coloproctol. 2015; 19: 753-5.
18. Bascom J. Pilonidal disease: Long-term results of follicle removal. Dis Colon Rectum.1983; 26: 800-7.
19. Umesh V, Sussman RH, Smith J, Whyte C. Long term outcome of the Bascom cleft lift procedure for adolescent pilonidal sinus. J Pediatr Surg. 2018; 53: 295-7.
20. Gavriilidis P, Bota E. Limberg ap versus Karydakis ap for treating pilonidal sinus disease: a systematic review and meta-analysis. Can J Surg. 2019; 62: 1-8.
21. Kartal A, Aydın HO, Oduncu M , Ferhatoglu MF, Kıvılcım T, Filiz AI. Comparison of three surgical techniques in pilonidal sinus surgery. Prague Med Rep. 2018; 119: 148-55.
22. 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; 4: CD006213.
23. 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.
24. Bali I, Aziret M, Sözen S, et al. Effectiveness of Limberg and Karydakis flap in recurrent pilonidal sinus disease. Clinics (Sao Paulo). 2015; 70: 350-5.
25. Ekici U, Kanlıöz M, Ferhatoglu MF, Kartal A. A comparative analysis of four different surgical methods for treatment of sacrococcygeal pilonidal sinus. Asian J Surg. 2019; 42: 907-13.
26. Halleran DR, Lopez JJ, Lawrence AE, Sebastiao YV, Fischer BA, Cooper JN, et al. Recurrence of pilonidal disease: our best is not good enough. J Surg Res. 2018; 232: 430-6.
27. 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.
28. Hardy EJO, Herrod PJ, Doleman B, Phillips HG, Ranat R, Lund JN. Surgical interventions for the treatment of sacrococcygeal pilonidal sinus disease in children: A systematic review and meta-analysis. J Pediatr Surg. 2019; 54: 2222-33.
29. Kalaiselvan R, Bathla S, Allen W, Liyanage A, Rajaganeshan R. Minimally invasive techniques in the management of pilonidal disease. Int J Colorectal Dis. 2019; 34: 561-8.
30. Milone M, Velotti N, Manigrasso M, Milone F, Sosa Fernandez LM, De Palma GD. Video-assisted ablation of pilonidal sinus (VAAPS) versus sinusectomy for treatment of chronic pilonidal sinus disease: a comparative study. Updates Surg. 2019; 71: 179-83.
31. Esposito C, Turrà F, Cerulo M, Del Conte F, Esposito G, Pini Prato A, et al. Technical standardization of MIS management of children with pilonidal sinus disease using pediatric endoscopic pilonidal sinus treatment (PEPSiT) and laser epilation. J Pediatr Surg. 2020; 55: 761-6.
32. Barbosa Sequeira J, 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: 2003-7.
33. Delshad HR, Dawson M, Melvin P, Zotto S, Mooney DP. Pit-picking resolves pilonidal disease in adolescents. J Pediatr Surg. 2019; 54: 174-6.
34. Speter C, Zmora O, Nadler R, Shinhar D, Bilik R. Minimal incision as a promising technique for resection of pilonidal sinus in children. J Pediatr Surg. 2017; 52: 1484-7.
35. Martínez Sanz N, Peña Ros E, Sánchez Cifuentes A, Benavides Buleje JA, Albarracín Marín-Blazquez A. Técnica de Karydakis modificada para el tratamiento del sinus pilonidal gigante. Cir Esp. 2016; 94: 609-11.
36. Esposito C, Gargiulo F, Izzo S, Cerulo M, Del Conte F, Severino G, et al. Pediatric endoscopic pilonidal sinus treatment: An effective procedure for children with recurrent pilonidal sinus disease after failed open surgery. J Laparoendosc Adv Surg Tech A. 2019; 29: 981-6.