



Inverted 'G' Technique without Loss of Skin Tissue Compared to Classical Open Surgery Technique in Pediatric Pilonidal Sinus Disease

Pediyatrik Pilonidal Sinüs Hastalığında Klasik Açık Cerrahi Tekniğine Göre
Deri Dokusunda Kayıp Olmaksızın Ters 'G' Tekniği

Murat KABAKLIOĞLU

 0000-0002-2894-0470

Murat KAYA

 0000-0001-6650-0145

Department of Pediatric Surgery,
Düzce University Faculty of Medicine,
Düzce, Turkey

ABSTRACT

Aim: Although the pilonidal sinus disease is commonly treated with surgical methods, search for optimal surgical procedures and minimally invasive methods continues. The aim of this study was to evaluate the inverted 'G' technique which provides a tension-free closure with minimal tissue loss, by comparing with the classical open surgery technique.

Material and Methods: Sixty-five patients, 37 (56.9%) male and 28 (43.1%) female, with a mean age of 15.85±1.82 years, admitted between January 2014 and October 2020 and underwent inverted 'G' surgery and classical midline open surgery were retrospectively evaluated.

Results: As an early postoperative complication, bleeding was observed in 2 (7.4%) patients in inverted 'G' group and 3 (11.1%) patients had wound infection. The same complications were 4 (10.5%) and 4 (10.5%) in classical group, respectively. The time to return to full activities was statistically different between two groups (10.36±0.43 versus 11.30±0.93 days, p<0.001). During the follow-up period, 1 (3.7%) recurrence in the inverted 'G' group and 9 (23.7%) recurrences in the classical group were statistically significant (p=0.037).

Conclusion: The present technique aims to remove the pathological tissue that causes sacrococcygeal pilonidal disease by the subcutaneous surgical work area under the flap created through the 'G' incision and to close it without tension, away from the midline without tissue loss. We believe that the operation involving the 'G' incision and primary suture method should be considered as the first choice in the pediatric patient group because of being a simple and effective surgical technique for sacrococcygeal pilonidal disease treatment.

Keywords: Sacrococcygeal sinus disease; children; surgery.

ÖZ

Amaç: Pilonidal sinus hastalığı genellikle cerrahi yöntemlerle tedavi edilmesine rağmen, optimal cerrahi prosedürler ve minimal invaziv yöntemler arayışı devam etmektedir. Bu çalışmanın amacı, minimal doku kaybı ile gerilimsiz bir kapatma sağlayan ters 'G' tekniğini klasik açık cerrahi tekniği ile karşılaştırarak değerlendirmektir.

Gereç ve Yöntemler: Ocak 2014 ve Ekim 2020 tarihleri arasında başvuran, ters 'G' cerrahi ve klasik orta hat açık cerrahi uygulanan, yaş ortalaması 15,85±1,82 olan 37'si (%56,9) erkek ve 28'i (%43,1) kadın 65 hasta geriye dönük olarak değerlendirildi.

Bulgular: Erken postoperatif komplikasyon olarak ters 'G' grubunda 2 (%7,4) hastada kanama görüldü ve 3 (%11,1) hastada yara enfeksiyonu vardı. Aynı komplikasyonlar klasik grupta sırasıyla 4 (%10,5) ve 4 (%10,5) idi. Tamamen normal yaşam aktivitelerine dönme süresi iki grup arasında istatistiksel olarak farklıydı (10,36±0,43'e karşı 11,30±0,93 gün, p<0.001). Takip süresi boyunca hastalarda ters 'G' grubunda 1 (%3,7) nüks, klasik grupta 9 (%23,7) nüks gelişmesi istatistiksel olarak anlamlı idi (p=0,037).

Sonuç: Mevcut teknik, sakrokoksiks pilonidal hastalığa neden olan patolojik dokuyu 'G' kesi ile oluşturulan flebin altındaki deri altı cerrahi çalışma alanı ile ortadan kaldırmayı ve orta hattın doku kaybı olmadan gerilimsiz kapatmayı amaçlamaktadır. Sakrokoksiks pilonidal hastalığın tedavisi için basit ve etkili bir cerrahi teknik olması nedeniyle pediatrik hasta grubunda 'G' insizyonu ve primer sütür yöntemini içeren operasyonun ilk seçenek olarak değerlendirilmesi gerektiğine inanıyoruz.

Anahtar kelimeler: Sakrokoksigeal sinus hastalığı; çocuk; cerrahi.

Corresponding Author

Sorumlu Yazar

Murat KABAKLIOĞLU
mkabaklioglu@gmail.com

Received / Geliş Tarihi : 26.04.2021

Accepted / Kabul Tarihi : 13.07.2021

Available Online /

Çevrimiçi Yayın Tarihi : 27.07.2021

INTRODUCTION

Mayo first described sacrococcygeal pilonidal disease (SPD) in 1883, but despite the passage of time and being a common disease, the search continues for the gold standard in treatment (1). The incidence of the disease gradually increases from the age of onset to adolescence and peaks in young adulthood. Although the incidence in the pediatric patient group was written to be 1.2-2 /10000, the number of studies about the treatment in this age group is quite low (2,3).

Although its etiology is not fully understood, recently it is believed to be an acquired disease. Being overweight, excessive hairy phenotype, long sitting periods and poor hygiene conditions are the main factors. Knowing these is important for post-treatment disease management (4).

Although the disease is commonly treated with surgical methods, the search for optimal surgical procedures and minimally invasive methods continues. Despite the success of surgical methods in recurrence, the main problems are wound opening due to the location of the pathological area, delay in healing and long-term effects on normal life activities. For this reason, asymmetric incisions (5) and various flap methods (6) have been developed to remove closure incisions from the midline. However, the main problem of these incisions is tissue loss, which further increases the tension in the process area (7).

We think that the inverted 'G' technique, which is a surgical technique that prevents skin tissue loss, provides a tension-free closure with minimal tissue loss. Especially in this age group, when the speed of wound healing is combined with this procedure, we aimed to evaluate this technique for the first time in the pediatric patient series in order to investigate the health of better tissue healing, less hospital stay and faster return to normal life in a less invasive manner.

MATERIAL AND METHODS

With the approval of the 2021/272 institutional review board, pediatric patients who applied to Düzce University Pediatric Surgery Clinic between January 2014 and October 2020 and underwent inverted 'G' surgery (group 1) and classical midline open surgery (group 2) were retrospectively evaluated.

After the surgical procedures were explained to the children and their parents in detail, the consent of the patients and their parents was obtained in writing, including the information that hospital data could be used. Twenty-seven pediatric patients included in our series were defined as type I-V according to the classification made by Tezel (8) according to the navicular area in SPD. Before deciding on the surgical technique, ultrasound imaging was performed to determine the location, size and content of the pilonidal sinus under the skin. All patients' age, gender, medical history of the family, body mass index (BMI), duration of symptoms, preoperative treatments, complaints at the time of application, number and location of sinus pits, type of anesthesia, duration of surgery, analgesia need, return to activity, complications, and recurrence were learned from the records. In all cases included in the series, sinus excisions with the 'G' incision technique were accomplished by a single surgeon. The choice of direction in the 'G' incision method for SPD depends on the location of the surgeon according to the

patient. When the surgeon is placed on the right side of the table, dissection can be easily performed under the flap formed by the 'G' incision made on the left side of the patient. Using the visual analog scale (VAS), we evaluated the pain perceived by the children from the day of operation to the 7th day. While the mean VAS score was 1.3 on the day of operation and increased to 3.0 on the 5th postoperative day in open surgery group, the mean vas score was 1.5 on the day of operation and decreased regularly in inverted 'G' group postoperatively. Also, the patients in inverted 'G' group stated that they did not feel any pain in the postoperative 5th day and after. We also recorded the number of postoperative laser treatments added to the treatment to prevent recurrence of the disease.

Ultrasound Imaging

Before the surgical procedure was decided in all patients, an ultrasound image was taken to determine the size and location of the sinus in the subdermal region. Right before the operation, the sinus position was drawn on the skin under ultrasound guidance (Figure 1).

Surgical Technique

Although spinal anesthesia was recommended for pediatric patients, the choice was left to them. After the child was laid prone under anesthesia, the intergluteal fold was removed from the midline with adhesive tapes. The borders were clarified by introducing methylene blue with mild pressure into the sinus. While the classical open surgical method is used with a midline incision as the first option in pediatric patients, we have given priority to the inverted 'G' technique in recent years. In this technique, taking care not to perforate the cyst, the orifis/es of sinus was cut off with a scalpel number 11 and separated from the skin. The flap, which will create a surgical work area under it, was lifted and laid in the opposite direction with a 'G' incision of an average width of 4 cm and a length of 7-8 cm, far from the midline (Figure 2). The orifice was moved from the flap into the surgical area with the help of a clamp. Using electrocautery, the cyst and surrounding dirty tissue were freed from the healthy tissue. After hemostasis, local field cleaning was performed with H₂O₂ and povidone-iodine, and a negative pressure hemovac drain is placed under the skin after the operating team changed their gloves with new ones. Approximation of the subcutaneous tissue was performed using 3/0 polyglactin suture. Primary closure was performed with Polypropylene using the Allgöwer-Donati suture technique. On the second postoperative day, the drain was withdrawn and the patient was sent home. Skin stitches were removed postoperatively on the 10th day if they were clean, but on the 15th day if they were dirty.

Follow-Up

Later, the patients were discharged to come for control on the 7th postoperative day and for stitch removal on the 14th day. Later, appointments were made by the surgeon as first month, sixth month and annual controls. They were called for a final check just before this research paper was designed. Patients included in the study were followed up and controlled for at least two years by the authors themselves.

Statistical Analysis

Shapiro-Wilk test was used to examine normality assumption, and Independent samples t test was used to analyze numerical variables with normal distribution while

Mann-Whitney U test was used for numerical variables showing not normal distribution. Categorical variables were analyzed with Pearson chi-square or Fisher's exact test. Descriptive statistics were given as mean±standard deviation or median, interquartile range, minimum, maximum values according to the distribution, and categorical variables were summarized with frequency and percentage. Statistical analyses were done by SPSS v.22 statistical package and 0.05 level was considered as statistical significance level.

RESULTS

Sixty-five patients, 37 (56.9%) males and 28 (43.1%) females, with a mean age of 15.85±1.82 years, were included in the study and 15 (23.1%) of them had first-degree relatives suffering from the same disease. The patients were divided into two groups according to the surgical procedure: group 1 inverted 'C' (27 patients) and group 2 classical open surgery (38 patients) group. Disease classification was made according to the navicular area concept (8). Primary symptoms were swelling in 17 (26.2%) patients, continuous purulent drainage in 15 (23.1%) patients, and intermittent discharge in 25 (38.5%) patients for all patients, and there was no significant difference between the groups (Table 1). There was a significant difference between the two groups in terms of symptom duration ($p=0.002$). Five (7.7%) of the operated patients were asymptomatic and presented with the complaint of a hole in the sacral region, and all of them were in the inverted 'C' group. There was no significant difference between the groups in terms of age ($p=0.124$), gender ($p=0.851$) and BMI ($p=0.442$).

All SPD removal procedures were made through a 'C' incision. Thus, wound closure was performed primarily with a suture line away from the midline (Figure 3). Despite careful dissection in 2 patients with type 3 SPD, the sinus cavity was entered incidentally. In the other group, the skin tissue in the form of a fish mouth in the middle line, including the sinus orifice, was completely removed with the cyst and closed primarily in the other group.

While there was no need for analgesia in patients operated on with spinal anesthesia, 24-hour postoperative analgesia was applied to those who were given general anesthesia. As an early postoperative complication, in the first group, 2 (7.4%) patients had minimal bleeding after the drain was removed, and 3 (11.1%) patients had wound infection that

resolved with antibiotic treatment. The same complications were 4 (10.5%) and 4 (10.5%) in the second group, respectively. While the mean length of stay in the hospital was 2.24±0.34 days in the first group, it took 4.03±0.34 days to return to normal activities. The same periods were 2.41±0.44 days of hospitalization and 4.16±0.39 days of returning to normal activities in the second group (Table 2). The time for our patients to return to full activities was statistically different between the two groups: 10.36±0.43 versus 11.30±0.93 days ($p<0.001$). During the follow-up period, 1 (3.7%) recurrence in the inverted 'C' group and 9 (23.7%) recurrences in the classical group developed in our patients ($p=0.037$).

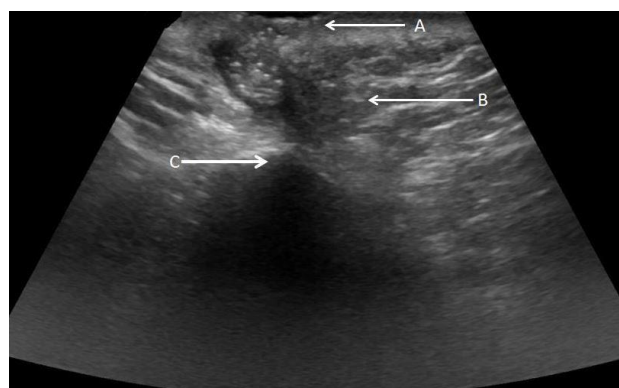


Figure 1. Preoperative ultrasonographic image of sacrococcygeal pilonidal disease

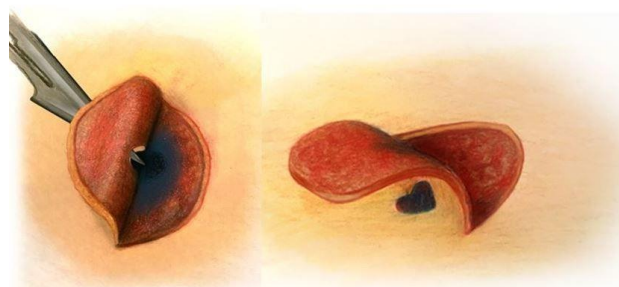


Figure 2. Schematic images of inverted 'C' flap; **A)** freeing the sinus orifices with a No.11 scalpel and view of the surgical work area under the flap; **B)** top view of the flap



Figure 3. Surgery pictures of sacrococcygeal pilonidal disease; **A)** marking the incision; **B)** deepening the incision towards the presacral area; **C)** Surgical workspace under the flap; **D)** Primary closure without tissue loss; **E)** healed view of the incision

Table 1. Demographic information and SPD types of patients

	Inverted 'G' (n=27)	Open Surgery (n=38)	p
Gender, n (%)			
Female	12 (44.4)	16 (42.1)	0.851
Male	15 (55.6)	22 (57.9)	
Age (years), mean±SD (min-max)	16.26±1.51 (13-18)	15.55±1.98 (11-18)	0.124
Body mass index, mean±SD (min-max)	28.41±3.11 (22.9-35.5)	29.02±3.10 (22.6-35.5)	0.442
Family history of SPD, n (%)	6 (22.2)	9 (23.7)	0.890
Duration of symptoms (month), median (IQR) (min-max)	5 (3) [2-24]	14.5 (14) [2-36]	0.002
Tezel classification, n (%)			
I	5 (18.5)	10 (26.3)	0.948
II	12 (44.4)	16 (42.1)	
III	7 (25.9)	8 (21.1)	
IV	0 (0.0)	0 (0.0)	
V	3 (11.1)	4 (10.5)	

SPD: sacrococcygeal pilonidal disease, SD: standard deviation, IQR: interquartile range

Table 2. Postoperative data in patients undergoing inverted 'G' technique and long-term follow-up

	Inverted 'G' (n=27)	Open Surgery (n=38)	p
Type of anesthesia, n (%)			
Spinal block	16 (59.3%)	21 (55.3)	0.749
General	11 (40.7%)	17 (44.7)	
Operation time (minute), mean±SD, (min-max)	36.81±3.82 (32-45)	37.05±4.05 (30-45)	0.812
Need for analgesia (hour), mean±SD (min-max)	23.89±3.15 (18-36)	24.87±3.78 (18-36)	0.275
Hospital stay (day), mean±SD (min-max)	2.24±0.34 (1.8-2.8)	2.41±0.44 (1.8-3.8)	0.086
Time to return to normal activity (day), mean±SD (min-max)	4.03±0.34 (3.6-5.0)	4.16±0.39 (3.6-5.0)	0.171
Time to return to full activity (day), mean±SD (min-max)	10.36±0.43 (9.6-11.0)	11.30±0.93 (9.8-12.8)	<0.001
Follow-up time (year), mean±SD (min-max)	2.66±0.49 (2.0-3.6)	2.96±0.32 (2.2-3.6)	0.004
Complications, n (%)			
Wound infection	3 (11.1%)	4 (10.5)	0.912
Bleeding	2 (7.4%)	4 (10.5)	
Recurrence, n (%)	1 (3.7%)	9 (23.7%)	0.037

SD: standard deviation

DISCUSSION

Although it may appear in other regions of the body, the pilonidal sinus is most commonly seen in the intergluteal sulcus in the midline sacrococcygeal zone. SPD mostly affects young adults after puberty and occurs predominantly in males of all age groups (9,10). In Turkey, in parallel with social security regulations, pediatric surgeons are more likely to encounter SPD, which peaks at the age of 16-25 but starts to appear at the age of 14-15, due to the fact that the pediatric age group is raised to 18 years of age. While it was known that pediatric surgeons rarely operated on pilonidal sinus disease cases in the previous years due to the low number of complicated cases in adolescence and early adolescence, in recent years, due to the interest of pediatric surgeons in this age group, cases operated in Turkey have been increasingly reported (11). Although a lot of medical and surgical treatment procedures have been defined to heal pilonidal sinus, none of them could eliminate the risk of recurrence (10). These treatments may cause restrictions in the postoperative period, to a greater extent than the problems caused by the disease itself (12). It is generally accepted that the treatment of choice for SPD is less invasive and should provide rapid wound healing, easy postoperative care,

short hospitalization, short return to normal life and a low recurrence ratio, but the gold standard has not yet been decided (13,14).

Although non-surgical methods are tried to be introduced to the literature, the most preferred treatment for SPD is surgery (15). Although complex and difficult flap techniques are used in complicated cases, less invasive techniques should be preferred instead of these methods in the treatment of primary disease: Excision and laying open of the sinus tract, narrow or wide and deep excision to the sacrum with primary closure, incision and marsupialization, asymmetrical incisions. In techniques of open surgery, the excision is left open with the expectation of secondary recovery, which means long-term treatment and late return to normal life. To overcome this disadvantage of leaving the wound open, various methods of primary closure in SPD surgical treatment have been reported (16,17).

The most difficult complication after primary closure surgery for SPD is a midline wound that does not heal permanently after excision or opens due to tension. With the previously developed asymmetric incisions, it was aimed to remove the primary closure away from the

midline and thus increase the healing rate and reduce the recurrence rate, but the skin loss in the incision could not bring the success rate to the desired level and caused complaints such as incision opening due to tension or discomfort in normal life.

A D-shape incision was developed to reduce these complications of primary closure. After the cyst borders are determined with methylene blue, the sinus holes are freed from the skin with an 11 scalpel and an asymmetrical excision is made with an average 8 cm long and 4 cm wide incision down to the presacral fascia with a 'G' shaped incision. The pilonidal sinus and surrounding tissue are totally removed by excision made lateral to the gluteal fascia and periosteum. After the surgical area is washed with hydrogen peroxide and povidone iodine, it is appropriate to place the aspiration drain into the cavity.

In the early period, no complications were encountered except minimal bleeding after removal of the hemovac drain in 2 patients and wound infection treated with antibiotics in 3 patients. While the complication rate was similar in the classical group, there was a significant difference in the number of recurrences. Despite more than 2 years of follow-up, just one of our inverted 'G' cases recurred. Compared to the literature, these rates are close to perfect (18). We think that the reason for the low recurrence rate is that it provides the opportunity to work comfortably in the large surgical area that occurs after flap removal and thus, the sinus and the surrounding dirty tissues can be removed completely. While providing this, we would like to add that the methylene blue we use in marking and moving away from the midline in the incision closure has an effect. Our recommendations for reducing the risk of recurrence for all of our patients have, of course, been; such as frequent showering, antiperspirant underwear, shorter sitting intervals and epilation.

The primary purpose of the inverted 'G' technique, which is the subject of the article, is to ensure the surgical wound is closed first without causing tension in the suture line with minimal tissue loss in the flap after sinus excision. The second goal was to place this closing line away from the midline. A surgical defect that can be closed with minimal strain after excision or other procedures is definitely the target of all surgeons as it will facilitate wound healing. In SPD, it is recommended to move this closure suture line away from the midline to prevent both wound healing and recurrence (19). The location of the surgeon relative to the inverted 'G' incision facilitates tissue dissection in the area under the flap. In our study, while removing the cysts, only the pit(s) were freed from the skin causing no tissue loss in the flap of the 'G' incision, which the surgical working area was located under. This enabled us to primary closure of the surgical wound with the least possible tension. In a population of pediatric patients undergoing a similar study, a trephine device was used to perform extensive resection with minimally invasive surgery and the wound was left open without sutures (20). Nevertheless, although this surgery was minimally invasive, it had high rates of reoperation (28%), and the cost of the authors to widen the excision to reduce the reoperation rate (9%) was both long 0 days (14 days) and a long transition time to full activity (45 days). In our series, we found significantly lower bleeding and infection rates, shorter recovery, and transition to full activity.

Karydakakis (21) demonstrated his own method to improve wound healing and reduce the recurrence rate and found a reoperation rate of less than 1 percent but the authors who followed him could not achieve the same rate, researchers such as Bascom (22) and Bruscianno et al. (19) tried to develop the method. The common point of these authors was that they aimed to remove the closure wound from the midline, but in order to completely remove the pathological tissue that caused the disease, it always removed together with the skin in the upper navicular area, causing a tense closure. Likewise, in all flap methods developed for the treatment of the disease, there was a loss in the skin tissue in the surgical area, which caused tensile closure of the wound. Doğan and his colleagues (23) developed a method in which the cyst can be removed completely without any skin loss and published it with a high success rate (recurrence rate 1.3%).

In our series, which is the first publication in the literature regarding the D-shaped incision in a series of pediatric patients, we think that the reason for the close-ratio of boys and girls to each other, contrary to the literature, is the earlier onset of the SPD process with the early start of puberty in girls.

We included patients who were followed for at least 2 years to evaluate the complication rates clearly. While initially following the asymptomatic cases in Group 1 with recommendations in accordance with the literature (24), we started to recommend surgery as the first option in this patient group as all these cases evolved into Groups 2 and 3 in the process.

CONCLUSION

In conclusion, the present technique aims to remove the pathological tissue that causes SPD by the subcutaneous surgical work area under the flap created through the 'G' incision and to close it without tension, away from the midline without tissue loss. Off the midline and tension-free primary wound closure provides better cosmetic recovery, less suffering, and an earlier return to the routine quality of life. The recurrence rate after subcutaneous sinus excision is almost perfect in pediatric patients with proper evaluation and compliance with surgical rules. We believe that the operation involving the 'G' incision and primary suture method should be considered as the first choice in the pediatric patient group because of being a simple and effective surgical technique for SPD treatment.

Ethics Committee Approval: The study was approved by the Ethics Committee of Düzce University Faculty of Medicine (04.01.2021, 272).

Conflict of Interest: None declared by the authors.

Financial Disclosure: None declared by the authors.

Acknowledgements: None declared by the authors.

Author Contributions: Idea/Concept: MK; Design: MK; Data Collection/Processing: MK, MKaya; Analysis/Interpretation: MK, MKaya; Literature Review: MK; Drafting/Writing: MK; Critical Review: MKaya.

REFERENCES

1. Hull TL, Wu J. Pilonidal disease. *Surg Clin North Am.* 2002;82(6):1169-85.
2. Arda IS, Güney LH, Sevmiş S, Hiçsönmez A. High body mass index as a possible risk factor for pilonidal sinus disease in adolescents. *World J Surg.* 2005;29(4):469-71.
3. Nasr A, Ein SH. A pediatric surgeon's 35-year experience with pilonidal disease in a Canadian children's hospital. *Can J Surg.* 2011;54(1):39-42.
4. Yildiz T, Elmas B, Yucak A, Turgut HT, Ilce Z. Risk factors for pilonidal sinus disease in teenagers. *Indian J Pediatr.* 2017;84(2):134-8.
5. Bascom J, Bascom T. Utility of the cleft lift procedure in refractory pilonidal disease. *Am J Surg.* 2007;193(5):606-9.
6. Yildiz T, Ilce Z, Küçük A. Modified Limberg flap technique in the treatment of pilonidal sinus disease in teenagers. *J Pediatr Surg.* 2014;49(11):1610-3.
7. Al-Khayat H, Al-Khayat H, Sadeq A, Groof A, Haider HH, Hayati H, et al. Risk factors for wound complication in pilonidal sinus procedures. *J Am Coll Surg.* 2007;205(3):439-44.
8. Tezel E. A new classification according to navicular area concept for sacrococcygeal pilonidal disease. *Colorectal Dis.* 2007;9(6):575-6.
9. Steele SR, Perry WB, Mills S, Buie WD; Standards Practice Task Force of the American Society of Colon and Rectal Surgeons. Practice parameters for the management of pilonidal disease. *Dis Colon Rectum.* 2013;56(9):1021-7.
10. 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(11):2222-33.
11. Duman K, Gırgın M, Harlak A. Prevalence of sacrococcygeal pilonidal disease in Turkey. *Asian J Surg.* 2017;40(6):434-7.
12. Senapati A, Cripps NP, Thompson MR. Bascom's operation in the day-surgical management of symptomatic pilonidal sinus. *Br J Surg.* 2000;87(8):1067-70.
13. Chintapatla S, Safarani N, Kumar S, Haboubi N. Sacrococcygeal pilonidal sinus: historical review, pathological insight and surgical options. *Tech Coloproctol.* 2003;7(1):3-8.
14. Vartanian E, Gould DJ, Lee SW, Patel KM. Pilonidal disease: Classic and contemporary concepts for surgical management. *Ann Plast Surg.* 2018;81(6):e12-e19.
15. Saber A, Bayumi EK. Sacrococcygeal pilonidal sinus disease. In: Shiffman MA, Low M, editors. *Biofilm, pilonidal cysts and sinuses. Recent clinical techniques, results, and research in wounds.* Cham, Switzerland: Springer Online; 2017. p.215-30.
16. Pfammatter M, Erlanger TE, Mayr J. Primary transverse closure compared to open wound treatment for primary pilonidal sinus disease in children. *Children (Basel).* 2020;7(10):187.
17. Pini Prato A, Mazzola C, Mattioli G, Escolino M, Esposito C, D'Alessio A, et al. Preliminary report on endoscopic pilonidal sinus treatment in children: results of a multicentric series. *Pediatr Surg Int.* 2018;34(6):687-92.
18. Limongelli P, Bruscianno L, Di Stazio C, del Genio G, Tolone S, Lucido FS, et al. D-shape asymmetric and symmetric excision with primary closure in the treatment of sacrococcygeal pilonidal disease. *Am J Surg.* 2014;207(6):882-9.
19. Bruscianno L, Limongelli P, Del Genio G, Tolone S, Amoroso V, Docimo G, et al. D-shape asymmetric excision of sacrococcygeal pilonidal sinus with primary closure, suction drain, and subcuticular skin closure: an analysis of risks factors for long-term recurrence. *Surg Innov.* 2015;22(2):143-8.
20. 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(9):1484-7.
21. Karydakakis GE. New approach to the problem of pilonidal sinus. *Lancet.* 1973;2(7843):1414-5.
22. Bascom J. Surgical treatment of pilonidal disease. *BMJ.* 2008;336(7649):842-3.
23. Dogan S, Cetin F, Gurleyik E. Inverse 'D' incision technique in treatment of pilonidal sinus disease; excision with minimal tissue loss, closure without tension and lateral location of the suture line. *Ann Surg Treat Res.* 2019;97(5):261-5.
24. Dindo D, Demartines N, Clavien PA. Classification of surgical complications: a new proposal with evaluation in a cohort of 6336 patients and results of a survey. *Ann Surg.* 2004;240(2):205-13.