

Comparison of Sinusectomy and Crystallized Phenol Procedure in Pilonidal Sinus Surgery

Pilonidal Sinüs Cerrahisinde Sinüsektomi ve Kristalize Fenol Uygulamasının Karşılaştırılması

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ÖZET

GİRİŞ ve AMAÇ: Pilonidal sinüs hastalığının cerrahi tedavi halen tartışmalı olup en iyi tedavi stratejisi hakkında görüş birliği yoktur. Çalışmamızda sinüsektomi yöntemi ile kristalize fenol yöntemini karşılaştırdık.

YÖNTEM ve GEREÇLER: Çalışmamız prospektif olarak tasarlanıp retrospektif olarak yapılmıştır. Çalışmamızda 2017-2020 yılları arasında komplike olmamış pilonidal sinüs hastalığı nedeniyle opere edilen 164 hasta dahil edildi. Hastaların 44'üne kristalize fenol, 120'sine sinüsektomi operasyonu uygulandı. Hastalar ortalama 16 ay takip edildi. Hastaların yaş, cinsiyet, operasyon şekli, primer yada nüks varlığı, sinüs sayısı, BMI indexleri, sinüs boyutu, kaç farklı alanda sinüs orifisinin olduğu, komplikasyonları, antibiyotik ve ağrı kesici kullanım süreleri, akıntı süreleri ve kapanma süreleri kayıt edildi.

BULGULAR: Kristalize fenol grubunda 35(%79.5) erkek 9(%20.5) kadın hasta mevcuttu. Sinüsektomi grubunda ise 105 (%87.5) erkek 15(%12.5) kadın hasta vardı. Hastaların yaş ortancası kristalize fenol grubunda 24(17-58), sinüsektomi grubunda 24.5(16-55) idi. Medyan işe dönüş süresi her iki grupta da 1 gün olarak bulundu, fakat kristalize fenol grubu daha kısa sürede işe döndü(p: 0,039). Sinüsektomi grubunda postoperatif kanama (%14.2) fazlayken kristalize fenol grubunda nüks(%4.5) daha fazla görüldü(p: 0.04). Sinüsektomi grubunda ortalama sinüs boyutu 2.5 cm iken kristalize fenol grubunda 1.3 cm (p<0.01) olarak hesaplandı. Kapanma süreleri her iki grupta da medyan 7 hafta olarak hesaplanırken istatistiksel olarak sinüsektomi grubunda daha geç bulunmuştur(p<0,01). Seröz akıntı süresi kristalize fenol grubunda 11 gün sinüsektomi grubunda 12 gün olarak hesaplandı(p<0.01). Ampirik antibiyotik olarak sinüsektomi grubunda daha çok amoksisilin+klavulanik asit (%89.2), kristalize fenol grubunda ise daha çok siprofloksasin +ornidazol (%59.1) kullanılmıştır(p<0.01).

TARTIŞMA ve SONUÇ: Erken dönem sonuçlarımıza göre sinüsektomi nüks açısından kristalize fenole göre daha üstün bulunurken, postoperatif kanama açısından kristalize fenol uygulaması daha etkilidir.

Anahtar Kelimeler: Pilonidal sinüs, kristalize fenol, sinüsektomi

ABSTRACT

INTRODUCTION: Surgical treatment of Pilonidal Sinus Disease (PSD) is still controversial and there is no consensus on the best treatment strategy. In our study, we compared sinusectomy method with (S) crystallized phenol(CP) method.

METHODS: Our study was designed prospectively and conducted retrospectively. In our study, 164 patients, who were operated for uncomplicated PSD between 2017-2020, were included. 44 of the patients underwent CP and 120 underwent S operation. Patients were followed for an average of 16 months. Age, sex, type of operation, presence of primary or recurrence, number of sinuses, BMI indexes, sinus size, how many different areas of sinus orifices, complications, duration of use of antibiotics and painkillers, discharge times and wound closure times were recorded in these patients.

RESULTS: In the CP group, there were 35 (79.5%) male and 9 (20.5%) female patients. In the S group, there were 105 (87.5%) male and 15 (12.5%) female patients. The median age of the patients was 24(17-58) in the CP group and 24.5 (16-55) in the S group. The median return to work time was 1 day in both groups, but the CP group returned to work in a shorter time period (p: 0.039). Postoperative bleeding was higher in the S group (14.2%) while recurrence was higher in CP Group (4.5%) (p: 0.04). The median sinus size was 2.5 cm in the S

group and 1.3 cm ($p<0.01$) in the CP group. Wound closure times were calculated as a median of 7 weeks in both groups and were statistically later in the group S ($p<0.01$). Serous discharge duration was calculated as 11 days in the CP group and 12 days in S group ($p<0.01$). In the S group, amoxicillin+clavulanic (89.2%) were used as empirical antibiotics and ciprofloxacin +ornidazole (59.1%) in the CP group ($p<0.01$).

DISCUSSION AND CONCLUSION: According to our early results, sinusectomy was found to be superior to crystallized phenol in terms of recurrence, while crystallized phenol application was more effective in terms of postoperative bleeding.

Keywords: Pilonidal sinus, crystallized phenol, sinusectomy

INTRODUCTION:

PSD was first described by Anderson in 1847(1). PSD is an inflammatory disease usually observed in the sacrococcygeal area in young men. Although its etiology is not yet fully known, the most widely accepted view is that it is acquired (2). Although the overall incidence is considered to be 26 in 100,000, this rate can vary from country to country. In a study conducted among Turkish soldiers, incidence was found to be 9% (3,4). Stiffness of body hair, taking 2 or less showers per week, sitting for more than 6 hours per day, family history, deep natal cleft predisposing are among risk factors (5,6,7). Many methods from minimally invasive methods to complicated flaps have been described as treatment methods. However, there is no gold standard method(8). The most important criterion in the ideal treatment method is the least recurrence. This should be achieved with minimal tissue loss, the earliest return time and the least scarring. Therefore, excision of CP and sinus tract (S) has become popular as conservative treatment in recent years (9).

In our study, we compared the efficacy of two popular methods, CP and S, in the treatment of pilonidal sinus.

MATERIALS AND METHODS:

Our study was designed prospectively and conducted retrospectively. In our study, 164 patients, who were operated for uncomplicated PSD between 2017-2020, were included. 44 of the patients underwent CP and 120 underwent S operation. Patients were followed for an average of 16 months. Age, sex, type of operation, presence of primary or recurrence, number of sinuses, BMI indexes, sinus size, how many different areas of sinus orifices, complications, duration of use of antibiotics and painkillers, discharge times and wound closure times were recorded in these patients.

Oral 875 grams of amoxicillin 125 g clavulanic acid (Augmentin 2*1 , GlaxoSmithKline

İlaçları San. ve Tic. A.Ş) or 500 mg ciprofloxacin (Cipro 2*1, Biofarma İlaç San. ve Tic. A.Ş.) 500 mg ornidazole (Biteral, 2*1, Deva Holding A.Ş) and 75 mg diclofenac sodium (Voltaren tb,2*1, Novartis Sağlık, Gıda ve Tarım Ürünleri San. ve Tic. A.Ş) were used post operatively for each patient.

Operational Procedures;

Crystallized Phenol Procedures : Before the procedure, preferably 1 day before the procedure, the patients were recommended to do hair and hygiene cleaning of the sacrococcygeal regions. After the patient was taken to the operating table in the prone position, skin sterilization was performed with povidone iodine. Following local anesthesia (Lidocaine Hydrochloride (20mg/ml) and Epinephrine (0.0125 mg/ml) base 10 ml), the hair inside the sinus was cleaned with a clamp. Sinus pouch was debrided with a surgical curette. Nitrofurazone cream (Furacin 2%, Eczacıbaşı İlaç San.ve Tic AŞ, İstanbul, Turkey) was applied around the sinus opening. Approximately 3-5 grams of crystallized phenol was released into the sinus pouch with the help of a clamp. It was expected to melt at body temperature. It was waited for 2 minutes by applying pressure with sponge, then the sinus pouch was debrided again. Empirical antibiotherapy was initiated to the patients, the patients came for dressing every two days and were closely followed up for 3 weeks. It was stated that it is not a problem to take a shower during this time.

Sinusectomy Procedures : Before the procedure, preferably 1 day before the procedure, the patients were recommended to do hair and hygiene cleaning of the sacrococcygeal regions. It was aimed to excision all infected tissue with intact surgical margins with as little skin islet as possible including all sinus openings under sterile conditions in Polyclinic conditions. If there is a fistula opening in the remote area, this fistula opening was not included in the excision area

if it did not produce a wide tissue defect when included in the excision area; If a large tissue defect occurs when the fistula opening is included in the excision area, a 2nd excision including the fistula opening is applied and the fistula tract in between is totally excised with intact surgical margins. Following the bleeding check, dressing was applied by pressing with antibiotic-impregnated sterile gauze. The procedure took an average of 15 minutes. The patient was given a single dressing the day after the procedure. If there is no bleeding in the dressing performed next day, the wound is left for secondary healing without additional treatment. The patient was advised to wash the wound every day without using any disinfectant agent (without dressing). He was advised not to sit on hard ground, to take care of regional cleanliness, not to use bicycles. Apart from these situations, all kinds of physical activities were allowed (such as doing heavy sports, swimming, sitting etc.). During follow-up, the patient was called for weekly control and wound closure was evaluated, and if necessary, debridement was performed. After approximately 6-8 weeks of follow-up, patients with no discharge and no scar of incision at the wound area were considered healed.

In our study, after the patient was taken to the operating table in prone position, skin sterilization was performed with the necessary povidone iodine. Following local anesthesia (Lidocaine Hydrochloride (20mg/ml) and epinephrine (0.0125 mg/ml) base 10 ml), the hairs in the sinus were cleaned with clamp. A mini elliptical incision was made to include the entire sinus tract. The subcutaneous tissue was completely removed by descending to the fascia layer. After bleeding control, the wound was left to secondary healing. Empirical antibiotherapy was started and the patients were followed-up for 7-8 weeks, with 1 dressing per week. It was stated that there is no problem for them to take a shower during this time and that the surgical wound should be washed with warm water every day.

Statistical Analysis: Statistical analyses were performed with the IBM SPSS for Windows Version 21.0. Numerical variables were summarized as median (minimum maximum). Categorical variables were summarized as frequency (percent). Normality of the

continuous variables was evaluated by Kolmogorov–Smirnov test. Differences between the groups for continuous variables were determined by Mann–Whitney U test. Categorical variable was compared with chi square test. A p value less than 0.05 was considered as significant.

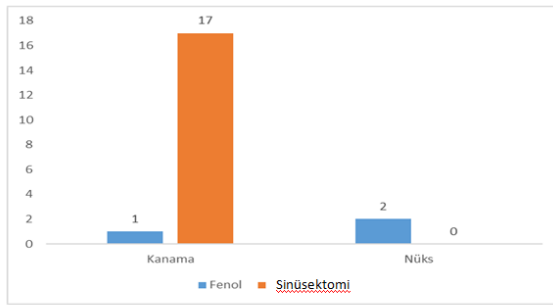
RESULTS

In the CP group, there were 35 (79.5%) male and 9 (20.5%) female patients. In the S group, there were 105 (87.5%) male and 15 (12.5%) female patients. The median age of the patients was 24(17-58) in the CP group and 24.5 (16-55) in the S group. The median return to work time was 1 day in both groups, but the CP group returned to work in a shorter time period ($p:0.039$). Postoperative bleeding was higher in the S group (14.2%) while recurrence was higher in CP Group (4.5%) ($p:0.04$). The median sinus size was 2.5 cm in the S group and 1.3 cm ($p<0.01$) in the CP group. Wound closure times were calculated as a median of 7 weeks in both groups and were statistically later in the group S ($p<0.01$). Serous discharge duration was calculated as 11 days in the CP group and 12 days in S group ($p<0.01$). In the S group, amoxicillin+clavulanic (89.2%) were used as empirical antibiotics and ciprofloxacin +ornidazole (59.1%) in the CP group ($p<0.01$). There was no statistically significant difference between the two groups in terms of primary or recurrence of cases taken, antibiotic cessation time, BMI, number of areas removed, and use of painkillers. ($p>0.05$)(Table-1).

When complications were compared, bleeding was observed higher in the sinusectomy group, while recurrence was observed higher in the crystallized phenol group (Graphic-1).

Table:1:Comparison of Crystallized Phenol and Sinusectomy Methods

Variables		Phenol	Sinusectomy	P value
Gender	Female	9 (20.5)	15 (12.5)	0,218
	Male	35 (79.5)	105 (87.5)	
Age		24.00 (17.00 - 58.00)	24.50 (16.00 - 55.00)	0,596
Primary	Primary	39 (88.6)	109 (90.8)	0,767
	Recurrence	5 (11.4)	11 (9.2)	
Antibiotic Cessation Time		10.00 (7.00 - 14.00) days	10.00 (7.00 - 15.00) days	0,737
BMI		27.00 (22.00 - 33.00)	26.00 (20.00 - 34.00)	0,887
Time To Return To Work		1.00 (1.00 - 2.00) day	1.00 (1.00 - 10.00) day	0,039
COMPLICATION	N/A	41 (93.2)	103 (85.8)	0,004
	Bleeding	1 (2.3)	17 (14.2)	
	Recurrence	2 (4.5)	0 (0)	
Number of Areas	1	38 (86.4)	97 (80.8)	0,434
	2	6 (13.6)	21 (17.5)	
	3	0 (0)	2 (1.7)	
Size		1.30 (0.50 - 7.00)cm	2.50 (1.30 - 9.00)cm	<0.001
Wound Closure Time		7.00 (6.00 - 8.00)weeks	7.00 (6.00 - 10.00)weeks	<0.001
Discharge Time		11.00 (10.00 - 14.00) days	12.00 (10.00 - 15.00)days	<0.001
Antibiotic	Ciprofloxacin + Ornidazole	26 (59.1)	13 (10.8)	<0.001
	Amoxicillin+ Clavulanic Acid	18 (40.9)	107 (89.2)	
Nsaid Time		5.00 (5.00 - 10.00)days	5.00 (3.00 - 10.00)days	0,865



Grafik-1: Kristalize Fenol ve Sinüsektomi Komplikasyonun karşılaştırılması

DISCUSSION:

In our study, we compared two methods commonly used in the treatment of pilonidal sinus. Postoperative bleeding was higher in the S group (14.2%) while recurrence was higher in CP Group (4.5%) (p:0.04). The median return to work time was 1 day in both groups, but the CP group returned to work in a shorter time period (p:0.039).

In recent years, minimally invasive methods have become more popular. Effective treatment method for PSD should be easy to apply with local anesthesia, simple, painless, cost-effective, does not require hospitalization, and most importantly, has a low recurrence (10). A gold standard treatment method for PSD has not yet been defined (11). Even indications of treatment around the world are different. German guideline does not recommend treatment for asymptomatic PSD. It recommends drainage of the abscess first and then elective operation after the abscess develops.(12) On the other hand, American guideline doesn't favor the non operative approach, asymptomatic PSD, without abscess (weak recommendation) (13). No treatment method in the treatment of PSD completely prevents recurrence in the long term. In very few surgical procedures, the recurrence rate was less than 10%. In long-term follow-up, more than 10% and less than 20% recurrence is acceptable.(14) G.Ureyen et al. emphasized that the most important factor for recurrence is the surgical method chosen (15). In our study, recurrence was 4.5% in the CP group during 16-month follow-up, whereas no recurrence was observed in the S group (0%).

Phenol, known as carbolic acid, may be in solid or liquid form. It has anesthetic, antiseptic and strong sclerotic effects(16). Phenol may be found in liquid or solid form. Solid-state crystallized phenol melts at body temperature,

irritates the pilonidal sinus cavity as a result of which granulation tissue is formed and the cavity closes. It is performed under local anesthesia and provides early return to work as a cost effect. It may cause necrosis on skin or fatty tissue during application.(17,18,19). If there are more than 3 pilonidal sinus orifice or abscess present, phenol efficacy has been shown to be low.(20). The use of phenol was banned by the German authorities due to its inhalation-induced toxicity in 1991 (21), and it was proposed to be used in selected patients in 2016.(12) Acute and chronic PSD without phenol abscess is also recommended in the American Society of Colon and Rectal Surgeons clinic practice guideline (Strong recommendation) (13). However, high recurrence rate compared to flap methods is the biggest disadvantage (22). Kayal et al. reported the success of phenol treatment at 2 ± 1.1 years of follow-up as $87 \pm 10\%$ (23). While Kayaalp et al.(24) reported the success of once applied phenol application as 70%, Emiroğlu et al (25) reported a success between 62-95%. Girgin et al. reported the success of phenol after laser hair removal as 100% (10). In our study, the success of crystallized phenol was found to be 95.5%.

Sinusectomy was first described by Soll et al.(26). The advantage of the procedure is that instead of wide excision, only excision of the sinus tract is performed. Soll et al. stated the 4-year recurrence rate as 7% in their study with the understanding of "less is more".(27) In fact "less is more" strategy is based on World War II. PDS was known as 'jeep disease' among American soldiers.(28,29) In order not to reduce the number of soldiers fighting Philippians proposed marsupization by removing less tissue(30). Sinusectomy is recommended for uncomplicated pilonidal sinuses with less than 3 orifices in the German national guideline (12). Radical excision and open wound management in the treatment of PSD has lost their popularity. Sinusectomy, a less aggressive method and / or unroofing, has become more popular with shorter recovery time, less pain, early return time to work, and similar recurrence rates(31,32). In our study, early (16) monthly success of sinusectomy was found to be 100%.

Gul et al. compared sinusectomy+primary closure(SPC) with excision+primary

closure(EPC); they observed 5.5% recurrence in the SPC Group and 18.7% recurrence in the EPC group during their 23-month follow-up. ($p < 0.01$) (14). Popeskou et al. compared the method of excision+primary repair with sinusectomy and found that the recurrence rate was 16% in the sinusectomy group and 11.1% in the excision+primary repair group during their 12-month follow-up, however, in the 12-month follow-up, the recurrence rate was 16% in the sinusectomy group and 11.1% in the excision + primary repair group, but was not statistically significant. ($P = 0.548$) (33). There are 2 prospective randomized trials comparing sinusectomy with conventional excision. Recurrence rates were found 0% (32%) in 10-month follow-up and 3% in 15-month follow-up (31). Bayhan et al. compared the application of crystallized phenol and modified limberg and found the recurrence rate in the phenol group as 18.9% and %6.8 in modified limberg application in the follow up of approximately 18 months, however it was not statistically significant ($p: 0.173$). (34). Turkoğlu et al compared simple primary closure with crystallized phenol; and found a recurrence rate of 28% in the simple primary closure group and 10.5% in the phenol group in the 27.5-month follow-up ($p: 0.03$) (35). Gecim et al compared endoscopic treatment with crystallized phenol treatment and did not see any significant difference in recurrence in their 24-month follow-up (36). There was no study comparing crystallized phenol and sinusectomy in our literature review.

The benefit of antibiotic use after PDS operation is not clear in the literature. (37) Amoxicillin / clavulanic acid, which was used for 5 days post-operatively after total excision and primary closure, has been shown to decrease wound infection in a 4-week observation. (12% -44%) (38) In another study, it was shown that the combination of metronidazole + ampicillin used for 1-4 days did not contribute to wound healing (77% & 73%) (39). In our study, mostly amoxicillin+clavulanic (89.2%) in the S group and mostly ciprofloxacin +ornidazole in the CP group (59.1%) were used as empirical antibiotics ($p < 0.01$). However, no effect was observed on wound healing and complications.

Limitations: Our study was designed prospectively and conducted retrospectively. The average follow-up period is 16 months and the results we present are our early results.

CONCLUSION:

According to our early results, sinusectomy is superior to crystalline phenol in terms of recurrence, while crystalline phenol is more effective in terms of post-operative bleeding. It is the first study comparing phenol and sinusectomy in our literature review. Prospective randomized studies are needed in this regard.

REFERENCES

1. Anderson AW. Hair extracted from an ulcer. *Boston Med Surg J* 1847;36:74–76
2. Chintapatla S, Safarani N, Kumar S, Haboubi N. Sacrococcygeal pilonidal sinus: historical review, pathological insight and surgical options. *Tech Coloproctol.* 2003;7:3e8.
3. 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.
4. Akinci OF, Bozer M, Uzunkoy A, Duzgun SA, Coskun A: Incidence and aetiological factors in pilonidal sinus among Turkish soldiers. *Eur J Surg* 1999; 165(4): 339–42.
5. Tokac M, Dumlu EG, Aydin MS, Yalcin A, Kilic M (2015) Comparison of modified Limberg flap and Karydakias flap operations in pilonidal sinus surgery: prospective randomized study. *Int Surg* 100(5):870–877. <https://doi.org/10.9738/inturg-d-14-00213.1>
6. Harlak A, Mentos O, Kilic S, Coskun K, Duman K, Yilmaz F (2010) Sacrococcygeal pilonidal disease: analysis of previously proposed risk factors. *Clinics (Sao Paulo)* 65(2):125–131. <https://doi.org/10.1590/s1807-59322010000200002>
7. Spivak H, Brooks VL, Nussbaum M, Friedman I (1996) Treatment of chronic pilonidal disease. *Dis Colon Rectum* 39(10):1136–1139
8. 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;190:388e392.
9. Isik A, Eryılmaz R, Okan I, et al. The use of fibrin glue without surgery in the treatment of pilonidal sinus disease. *Int J Clin Exp Med.* 2014;7:1047e1051
10. Girgin M, Kanat BH, Ayten R, et al. Minimally invasive treatment of pilonidal disease: crystallized phenol and laser depilation. *Int Surg.* 2012;97:288e292.
11. Pappas AF, Christodoulou DK (2018) A new minimally invasive treatment of pilonidal sinus disease with the use of a diode laser: a prospective large series of patients. *Color Dis* 20(8):207–214.
12. Iesalnieks I, Ommer A, Petersen S, et al. German national guideline on the management of pilonidal disease. *Langenbecks Arch Surg* 2016;401:599–609



13. Johnson EK, Vogel JD, Cowan ML, et al. The American society of colon and rectal surgeons' clinical practice guidelines for the management of pilonidal disease. *Dis Colon & Rectum* 2019;62:146-5
14. Gül V.O, Destek S. Conservative Sinusectomy vs. excision and primary off-midline closure for pilonidal disease: a randomized controlled trial. *International Journal of Colorectal Disease*.2020;3575:1
15. Üreyen O, Tekeli M.T, Üstüner M.A. Bacterial colonization in uninfected pilonidal cyst and its role in developing recurrence in postoperative period: Prospective study. *Annals of Medical Research*. 2019;26(7):1210-3
16. 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;29:162e166
17. Dogru O, Camci C, Aygen E, Girgin M, Topuz O. Pilonidal sinus treated with crystallized phenol: an 8 year experience. *Dis Colon Rectum*. 2004;47:1934e1938.
18. Kayaalp C, Olmez A, Aydin C, Piskin T, Kahraman L. Investigation of a one-time phenol application for pilonidal disease. *Med Princ Pract*. 2010;19:212e215
19. Topuz O, So"zen S, Tu"kenmez M, Topuz S, Vurdem UE. Crystallized phenol treatment of pilonidal disease improves quality of life. *Indian J Surg*. 2014;76:81e84.
20. Dag A, Colak T, Turkmenoglu O, Sozutek A, Gundogdu R. Phenol procedure for pilonidal sinus disease and risk factors for treatment failure. *Surgery*. 2012;151:113e117
21. Bruce RM, Santodonato J, Neal MW (1987) Summary review of the health effects associated with phenol. *Toxicol Ind Health* 3: 535–568
22. Girgin M, Kanat BH. The results of a one-time crystallized phenol application for pilonidal sinus disease. *Indian J Surg*. 2014;76:17e20
23. Kayal A, Hussain A, Choudhary A, Meghwal A (2014) A comparative study between Karydakis flap reconstruction and doubleZ-Plastyin patients with Sacrococcygeal Pilonidal disease. *Int Sch Res Notices* 2014:523015
24. Kayaalp C, Aydin C. Review of phenol treatment in sacrococcygeal pilonidal disease. *Tech Coloproctol* 2009;13:189-93
25. Emiroglu M, Karaali C, Esin H, et al. Treatment of pilonidal disease by phenol application. *Turk J Surg* 2017;33:5-9.
26. Soll C, Hahnloser D, Dindo D, Clavien PA, Hetzer F (2008) A novel approach for treatment of sacrococcygeal pilonidal sinus: less is more. *Int J Color Dis* 23(2):177–180.
27. Soll C, Dindo D, Steinemann D, Hauffe T, Clavien PA, Hahnloser D (2011) Sinusectomy for primary pilonidal sinus: less is more. *Surgery* 150(5):996–1001.
28. Buie LA, Curtiss RK. Pilonidal disease. *Surg Clin North Am* 1952:1247-59.
29. Casberg MA. Infected pilonidal cysts and sinuses. *Bull U S Army Med Dep* 1949;9:493-6.
30. Phillips CW. Pilonidal disease in a military hospital. *J Natl Med Assoc* 1954;46:329-32.
31. Mohamed HA, Kadry I, Adly S (2005) Comparison between three therapeutic modalities for non-complicated pilonidal sinus disease. *Surgeon* 3:73–77
32. Oncel N, Kurt M, Kement M, Colak E, Eser M, Uzun H (2002) Excision and marsupialization versus sinus excision for the treatment or limited chronic pilonidal disease: a prospective, randomized trial. *Tech Coloproctol* 6:165–169
33. Popeskou S.G, Barbara P , Sofoklis P, et al. Conservative Sinusectomy vs. excision and primary off-midline closure for pilonidal disease: a randomized controlled trial. *International Journal of Colorectal Disease*.2020;3551-9.
34. Bayhan Z, Zeren S, Duzgun SA, Ucar BI, Alparslan Yumun HN, Mestan M (2016) Crystallized phenol application and modified Limberg flap procedure in treatment of pilonidal sinus disease: a comparative retrospective study. *Asian J Surg* 39:172–177
35. Turkoglu A, Bozdog Z, Gumus M, et al. Comparison of Crystallized Phenol Treatment and Simple Primary Closure Methods for Pilonidal Sinus Disease. *Int Surg* 2018;103:424–428
36. Gecim IE., Goktug UU., Celasin H., Endoscopic pilonidal sinus treatment combined with crystalized phenol application may prevent recurrence, *Dis Colon Rectum*, 2017, 60(4), 405–407
37. Mavros MN, Mitsikostas PK, Alexiou VG, Peppas G, Falagas ME. Antimicrobials as an adjunct to pilonidal disease surgery: a systematic review of the literature. *Eur J Clin Microbiol Infect Dis*. 2013;32:851–858
38. Chaudhuri A, Bekdash BA, Taylor AL. Single-dose metronidazole vs 5-day multi-drug antibiotic regimen in excision of pilonidal sinuses with primary closure: a prospective, randomized, double-blinded pilot study. *Int J Colorectal Dis*. 2006;21:688–692.
39. Lundhus E, Gjode P, Gottrup F, Holm CN, Terpling S. Bactericidal antimicrobial cover in primary suture of perianal or pilonidal abscess: a prospective, randomized, double-blind clinical trial. *Acta Chir Scand*. 1989;155:351–354.