



# Early versus delayed endoscopic treatment of acute pilonidal abscess: a propensity score-matched analysis

Michele Manigrasso<sup>1</sup> · Nunzio Velotti<sup>1</sup> · Loredana M. Sosa Fernandez<sup>1,2</sup> · Sara Vertaldi<sup>1</sup> · Francesco Maione<sup>3</sup> · Nicola Gennarelli<sup>3</sup> · Pietro Schettino<sup>3</sup> · Mario Musella<sup>1</sup> · Giovanni D. De Palma<sup>3</sup> · Marco Milone<sup>3</sup>

Accepted: 30 September 2020

© Springer-Verlag GmbH Germany, part of Springer Nature 2020

## Abstract

**Background** According to the Italian Society of Colorectal Surgery guidelines, the most effective approach to the pilonidal abscess is adequate surgical drainage, concerning incision and drainage of the pilonidal cavity. Few recent studies have demonstrated that endoscopic approach could be a valid treatment option even in the case of acute pilonidal abscess. The aim of our study is to assess if video-assisted ablation of pilonidal sinus (VAAPS) could be an alternative to treat an acute pilonidal abscess and to evaluate if an immediate endoscopic approach to the pilonidal abscess is preferable to a delayed procedure after incision and drainage.

**Methods** All consecutive patients with an acute pilonidal abscess since 1 January 2014 to 31 December 2018 were enrolled in our propensity score-matched analysis and divided into two groups: the early VAAPS group and the delayed VAAPS group. Primary outcomes were recurrence rate at 1-year, 3-year, and 5-year follow-up. Secondary outcomes were time off, time to wound healing, incomplete wound healing, perioperative infection, patients' satisfaction 1 month after the complete wound healing, and their health status before surgery and 6 months after complete wound healing.

**Results** After the propensity score matching, 82 patients were included in the final analysis (41 in each group). No differences were found in terms of recurrence in the two groups. Early endoscopic approach was associated with a better patients' satisfaction ( $8.17 \pm 1.2$  vs  $6.06 \pm 1.48$ ,  $p = 0.001$ ) and a better postoperative health status ( $86.27 \pm 6.54$  vs  $77.32 \pm 5.85$ ,  $p = 0.001$ ).

**Conclusions** Our results encouraged to perform an immediate endoscopic approach to an acute pilonidal abscess.

**Keywords** Pilonidal · Endoscopic treatment · Video-assisted ablation · Acute abscess

## Introduction

Pilonidal sinus (PS) is a common disease of the natal cleft of the sacrococcygeal area. Acute abscess is a common surgical presentation with a reported incidence of about 26 per 100,000. According to the Italian Society of Colorectal Surgery guidelines [1], the most effective approach to the pilonidal abscess is adequate surgical drainage of the pilonidal

cavity [2]. However, up to 42% of patients fail to heal after drainage, and a second surgical treatment is needed in 15–40% of cases [3].

Few recent studies have demonstrated that endoscopic approach could be a valid alternative in case of acute pilonidal abscess [4, 5].

However, although if the video-assisted ablation of pilonidal sinus (VAAPS) has been recognized as safe and effective for chronic pilonidal disease in terms of recovery outcomes [6, 7] and long-term recurrence [8], less is known about the adoption of this technique to treat an acute presentation of pilonidal disease.

The aim of this study is to assess if VAAPS [9] could be considered as a valid treatment in case of acute pilonidal abscess. Furthermore, in our study, we would assess if an immediate endoscopic approach can be safe as a delayed procedure performed 1 month after incision and drainage of the abscess in terms of recurrence at 1-year, 3-year, and 5-year follow-up.

✉ Michele Manigrasso  
michele.manigrasso@unina.it

<sup>1</sup> Department of Advanced Biomedical Sciences, “Federico II” University of Naples, Via Sergio Pansini, 5, 80131 Naples, Italy

<sup>2</sup> EMBRYOS Fertility Center and Day Surgery, Palazzo Colosseum, Via Fiorignano, 84091 Battipaglia, Salerno, Italy

<sup>3</sup> Department of Clinical Medicine and Surgery, “Federico II” University of Naples, Via Sergio Pansini, 5, 80131 Naples, Italy

Thus, a comparative study between early video-assisted treatment and delayed video-assisted treatment was conducted at our Institution.

## Materials and methods

Institutional Review Board approval was obtained before review of any patient material. From a prospectively maintained database of the VAAPS, all consecutive patients with the first episode of an acute pilonidal abscess enrolled since 1 January 2014 to 31 December 2018 were included in the study. There were no exclusion criteria; the patient who declined to participate to the trial were excluded from the study.

The enrolled patients were divided into two groups: the early VAAPS group and the delayed VAAPS group.

In the early VAAPS group, after an outpatient's clinical diagnosis of acute pilonidal abscess, patients were admitted after 1 day to our department and operated in an emergency setting by VAAPS procedure. An antibiotic prophylaxis with ciprofloxacin 400 mg and metronidazole 500 mg *per venam* was administered perioperatively. Patients were discharged in the late afternoon on the same day of the surgical procedure, and a therapy with ciprofloxacin 500 mg twice a day and metronidazole 250 mg three times a day for 3 days was prescribed.

In the delayed VAAPS group, after an outpatient diagnosis, patients were admitted after 1 day to our department and an incision and drainage of the abscesses was performed. Then, to all the patients were administered an antibiotic therapy for 3 days with ciprofloxacin 500 mg twice a day and metronidazole 250 mg three times a day. After 1 month, if the inflammatory process was controlled, patients were undergone to elective VAAPS procedure.

All patients were examined during follow-up with a physical examination after 1 day, 1 week, 1 month, 6 months, 1 year, and then annually.

## Surgical techniques

All patients were operated on with standardized surgical techniques. All the procedures were performed under local anesthesia with 30–60 mL of mepivacaine (Carbosen, 20 mg/mL; Galenica Senese). The patients were placed in the prone position with the hips slightly flexed and the buttocks were retracted with an adhesive tape. A primary incision and drainage of the pilonidal abscess, followed by VAAPS after 1 month, was performed in the delayed VAAPS group, while a primary endoscopic treatment of the abscess was performed in the early VAAPS group.

In case of incision and drainage, a small incision (about 1 cm) over the most fluctuant part of the abscess was

performed, and after the drainage of the abscess, an irrigation was performed with saline solution to wash the abscess cavity.

The VAAPS procedure was performed as previously described [9, 10] by using a 4-mm continuous flow operative hysteroscope (Bettocchi Office Hysteroscope “size 4”, Karl Storz) with a 30°-grade optic, which incorporated a 5-Fr operative channel.

In the case of early VAAPS group, after a small 1-cm incision of the abscess, the endoscope was inserted through the orifice, and the abscess cavity was irrigated with a continue flow of saline solution. After the complete washing and drainage of the cavity, a mechanical adhesiolysis was performed with the grasping forceps and the hairs were removed, if present. Then the sinus cavity was completely ablated by using a 5-Fr bipolar electrode under continuous vision, and a complete cleaning of the sinus cavity was performed with the Volkmann spoon. No surgical drain was positioned at the end of the procedure, as suggested by the current literature [11].

All the procedures were performed by a single surgeon with the highest level of skill in VAAPS (M.M.).

## Outcomes

Outcomes were divided into primary and secondary outcomes.

Primary outcomes of the study were recurrence rate at 1-year, 3-year, and 5-year follow-up.

Secondary outcomes were time off work (divided into surgical time off work after VAAPS procedures and overall time off work), time to wound healing, incomplete wound healing, perioperative infection, patients' satisfaction 1 month after the complete wound healing, and their health status before surgery and 6 month after complete wound healing.

Recurrence was defined as an additional occurrence of symptoms of the disease after an interval following complete wound healing.

Surgical time off work was considered as the time for returning to work after VAAPS procedure, while overall time off work consisted of a sum of the days of inactivity after the two surgical procedures (as in the delayed VAAPS group). The criteria for returning to work was the absence of any limitation to normal daily activities, including no pain while resting or moving, walking, and sitting, and no need to dress the wound more than once a day.

Time to wound healing was defined as the days necessary to obtain a complete closure of the 1-cm skin incision in absence of any wound discharge.

Incomplete wound healing was defined as persisting wound discharge or swelling after postoperative day 60.

Wound infection was defined as redness and/or edema of the skin and/or discharge. Only wound infections after VAAPS procedure were considered; patients in which an

infection occurred within the month between incision and drainage and endoscopic procedure were excluded from the study.

Patients' satisfaction was obtained by a numeric scale, which ranged from 0 for no satisfaction to 10 for a complete satisfaction. An independent observer, unaware of the allocation of each patient, collected the satisfaction scale evaluation.

Finally, health status was assessed by using SF-36 (validated Italian version), before the admission and 6 months after the complete healing [12].

Demographic data (age, gender, BMI, and smoking status) were also recorded.

## Statistical analysis

Continuous variables are compared by the Mann–Whitney *U* test, and categorical variables are compared by the  $\chi^2$  test. A *p* value of  $< 0.05$  was defined as statistically significant.

Propensity scores were estimated using a logistic regression model based on age, gender, BMI, and smoking status. One-to-one matching without replacement was performed with a 0.1 caliper width, and the resulting score-matched pairs were used in subsequent analyses. Baseline characteristics and operative and postoperative variables were compared using a multivariate analysis. Statistical analysis was performed with SPSS version 20.0 (IBM, Armonk, NY).

## Results

Our analysis included data of 150 patients. After the propensity score analysis (Fig. 1), a total of 82 patients with acute pilonidal abscess were enrolled to early VAAPS (41 patients) and delayed VAAPS (41 patients). Follow-up was at 1 year for all the patients, at 3 years for 38 patients (20 patients in the early VAAPS group and 18 in the delayed VAAPS group) and at 5 years for 16 patients (8 in each group).

No significant differences were found between the two groups in terms of age, gender, BMI, and smoking status (Table 1).

Primary and secondary outcomes are summarized in Table 2.

No significant differences were found in terms of recurrence rate at 1-year (4.9% vs 7.3%,  $p = 0.644$ ), 3-year (10% vs 16.6%,  $p = 0.543$ ), and 5-year follow-up (25% vs 37.5%,  $p = 0.589$ ). A detailed distribution of the recurrences is shown in Fig. 2. Regarding follow-up, it is important to underline that 3-year follow-up was reached by 38 patients (20 patients in the early VAAPS group and 18 in the delayed VAAPS group) and 5-year follow-up was completed only by 16 patients (8 in each group).

The mean surgical time off work in the early VAAPS group was similar with the delayed VAAPS group ( $3.89 \pm$

$1.54$  vs  $3.99 \pm 1.37$ ,  $p = 0.567$ , respectively). However, considering for the delayed VAAPS group time off work derived by the incision and drainage of the abscess cavity, the overall time off work was significantly shorter in favor of the early VAAPS group ( $3.89 \pm 1.54$  vs  $6.92 \pm 21.78$ ,  $p = 0.001$ ).

No significant differences were found in terms of time to wound healing ( $26.76 \pm 12.09$  vs  $28.31 \pm 14.16$ ,  $p = 0.721$ ) and incomplete wound healing (4.9% vs 7.3%,  $p = 0.644$ ).

Even the infection rate after VAAPS was similar between the two groups (2.4% vs 7.3%,  $p = 0.305$ ).

Analysis of satisfaction scale evaluation showed that all the enrolled patients have a good satisfaction 1 month after complete healing (average =  $7.11 \pm 1.71$ ), with a significant difference between the two groups in favor of early VAAPS ( $8.17 \pm 1.2$  vs  $6.06 \pm 1.48$ ,  $p = 0.001$ ). Finally, a significant improvement in the health status was obtained in both of the groups comparing preoperative period and 6 months after the complete healing ( $74.67 \pm 8.35$  vs  $86.27 \pm 6.54$  in the early VAAPS group and  $63.58 \pm 8.60$  vs  $77.32 \pm 5.85$  in the delayed VAAPS,  $p = 0.001$  in both of the groups). Similar results were obtained in the two group in terms of health status before the admission ( $64.76 \pm 8.35$  vs  $63.58 \pm 8.60$ ,  $p = 0.774$ ), while a significant difference was obtained 6 months after the complete wound healing in favor of early VAAPS procedure ( $86.27 \pm 6.54$  vs  $77.32 \pm 5.85$ ,  $p = 0.001$ ).

After adjusting for all other variables (sex, age, BMI, smoking status), no parameters showed an influence on the risk of postoperative complications.

## Discussion

The introduction of endoscopic treatment of pilonidal sinus disease has revolutionized the surgical approach to this troublesome disease. In fact, Meinero et al. [13] and, independently, Milone et al. [9] developed and described two new endoscopic techniques: the EPSiT and the VAAPS. The concept of these new treatments was to create a minimal elliptical wedge of the subcutaneous tissue, including all the inflamed tissue and debris, leaving the overlying skin intact.

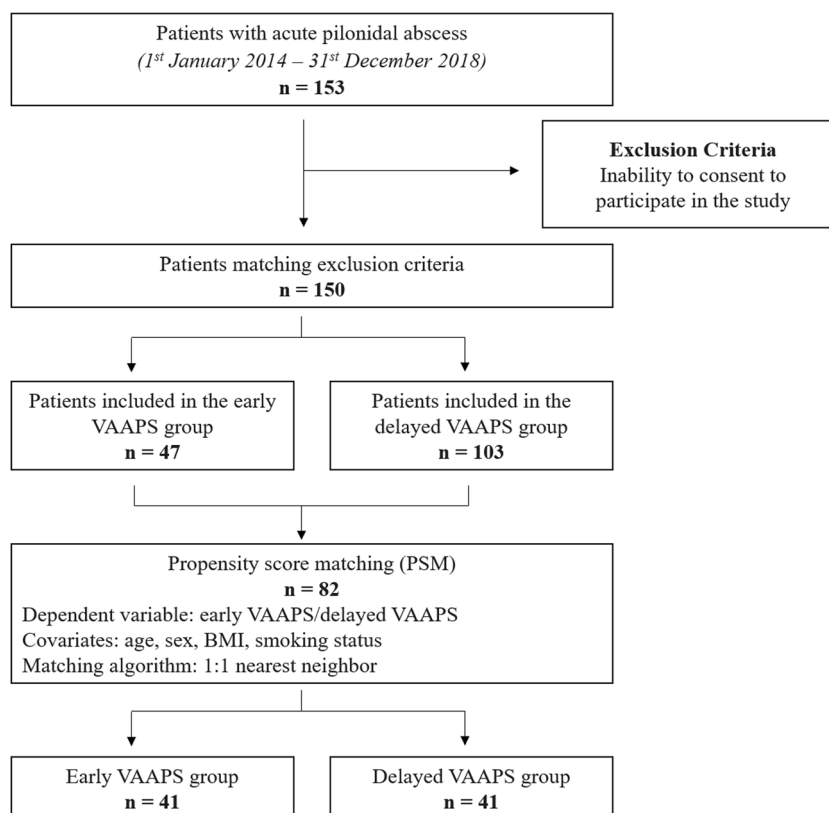
Recently, several studies have demonstrated the advantages of these techniques, associated with less postoperative pain, better cosmetic results and patients' satisfaction [6–9, 13–16].

Furthermore, the effectiveness of endoscopic treatment was confirmed also in terms of long-term recurrence, with low recurrence rate [8, 17].

However, although the endoscopic approach seems to be a valid therapeutic option to treat chronic pilonidal sinus, less is known about the endoscopic approach to acute pilonidal abscesses.

According to national and international guidelines [1, 18–20], the mainstay of treatment for an acute pilonidal

**Fig. 1** Patients' enrollment pre- and post-propensity score matching



abscess remains nowadays an adequate surgical drainage [2]. However, up to 42% of patients fail to heal, and for those healing initially, a second definitive treatment is necessary in a lot of cases [3].

An endoscopic approach to treat an acute pilonidal abscess has been proposed, but data about this topic are scarce and anecdotal in current literature [4, 5].

Few years ago, Jain et al. [4] collected data from 19 patients with an acute presentation of pilonidal sinus disease treated with endoscopic approach. The results showed that the endoscopic pilonidal abscess treatment (EPAT) was time consuming, if compared with simple incision and drainage of the abscess, but cost-effective, owing to reduced hospital stay and early return to daily activities. Thus, authors concluded that endoscopic pilonidal abscess treatment is an effective procedure for the treatment of acute pilonidal presentation, associated with reduced morbidity and rapid wound healing.

Same conclusions were obtained by Javed et al. [5] 1 year later, in their comparison between EPAT and drainage alone of the acute pilonidal abscess. In detail, from the analysis of 40 patients, twenty in each group, definitive surgery was necessary in 20% of cases in both of groups, but time off work and postoperative pain were significantly lower in the EPAT group.

Our results are in line with the current literature and confirmed the effectiveness of the VAAPS procedure in the treatment of acute pilonidal abscess.

Furthermore, we have tried to assess which could be the best timing to perform an endoscopic treatment, comparing an early approach with a delayed treatment after a standard incision and drainage of the acute abscess.

The efficacy of an early treatment of an acute pilonidal abscess is showed by the recurrence rate obtained in our study. In fact, similar results were obtained between early and

**Table 1** Demographic characteristics of the included patients

Characteristics	Early VAAPS (n = 41)	Delayed VAAPS (n = 41)	p value
M/F (%)	27/14 (65.8%/34.2%)	25/16 (60.9%/39.1%)	0.819
Age (years)	27.68 ± 2.24	28.02 ± 1.88	0.303
BMI (kg/m <sup>2</sup> )	27.2 ± 3.07	27.88 ± 5.63	0.305
Smokers (%)	16 (39%)	18 (43.9%)	0.823

Age and BMI are expressed as mean ± SD

**Table 2** Postoperative outcomes

Postoperative outcomes	Early VAAPS ( <i>n</i> = 41)	Delayed VAAPS ( <i>n</i> = 41)	<i>p</i> value
Recurrence at 1 year FU (%)	2 (4.9%)	3 (7.3%)	0.589
Recurrence at 3 years FU* (%)	2 (10%)	3 (16.6%)	0.543
Recurrence at 5 years FU* (%)	2 (25%)	3 (37.5%)	0.589
Surgical time off work	3.89 ± 1.54	3.99 ± 1.37	0.567
Overall time off work	3.89 ± 1.54	6.92 ± 1.78	<b>0.001</b>
Time to wound healing	26.76 ± 12.09	28.31 ± 14.16	0.721
Incomplete wound healing (%)	2 (4.9%)	3 (7.3%)	0.644
Infection (%)	1 (2.4%)	3 (7.3%)	0.305
Post-healing patients' satisfaction	8.17 ± 1.2	6.06 ± 1.48	<b>0.001</b>
Preoperative SF-36	64.76 ± 8.35	63.58 ± 8.60	0.774
6-month postoperative SF-36	86.27 ± 6.54	77.32 ± 5.85	<b>0.001</b>

\*The 3-year follow-up was completed by 38 patients (20 in the early VAAPS group and 18 in the delayed VAAPS group). The 5-year follow-up was completed by 16 patients (8 in each group). Surgical time off work, overall time off work, time to wound healing, post-healing patients' satisfaction, preoperative SF-36, and 6-month postoperative SF-36 are expressed by mean ± SD. *FU* follow-up

delayed VAAPS group in terms of recurrence rate at 1-year, at 3-year, and at 5-year follow-up.

Comparing our results with the most recent meta-analysis on long-term outcomes of endoscopic treatment of pilonidal sinus [16], we can confirm that an early endoscopic approach could be a valid alternative even in case of an acute pilonidal abscess.

In fact, recurrence rate reported by Emile et al. [16] in their meta-analysis was about 4%, with a weighted mean failure of the technique about 6%. Our 1-year recurrence rate is about 5% in the early VAAPS group and about 7% in the delayed group, in line with the current literature.

Furthermore, our results confirmed that an early approach to an acute pilonidal abscess is associated with a shorter period of inactivity, if compared with a delayed approach.

In fact, the mean surgical time off work was similar in the two groups, but considering for the delayed VAAPS group

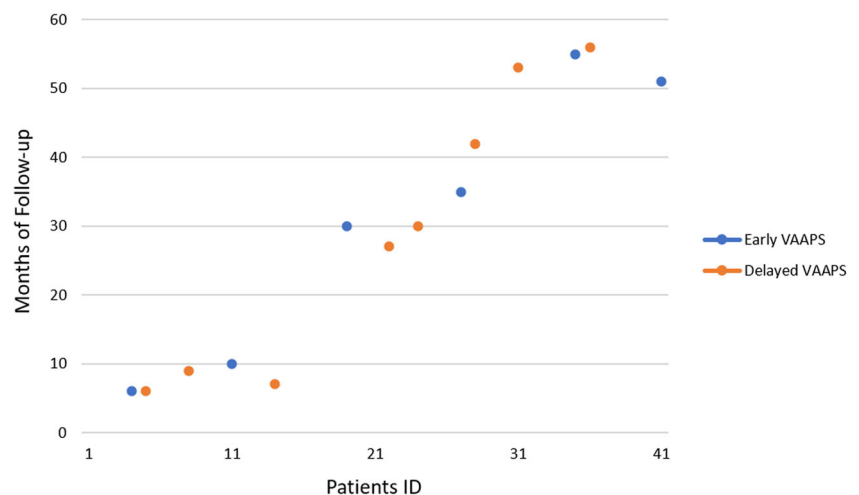
time off work derived by the incision and drainage of the abscess cavity, the overall time off work was significantly shorter in favor of the early VAAPS group.

Postoperative results showed that the mean time to wound healing, incomplete wound, and postoperative infection were similar in the two groups, confirming the safety of an early procedure.

In the meta-analysis performed by Emile et al. [16], the mean time to complete healing was about 33 days and the mean time to return to work and normal activities about 3 days. Our results are comparable to the current literature, confirming the feasibility of this procedure in case of pilonidal abscess.

Finally, an early approach seems to be related with a better patients' satisfaction, probably due to the fact that only one surgical procedure was performed to obtain a definitive healing. In fact, analysis of satisfaction scale evaluation showed that all the enrolled patients have a good satisfaction

**Fig. 2** Detailed distribution of the recurrences. On the *x*-axis, the patients' identification number (ID, numbered from 0 to 41). On the *y*-axis, the follow-up period (expressed as month)





1 month after complete healing (average =  $7.11 \pm 1.71$ ), but a significant difference between the two groups in favor of early VAAPS was obtained.

However, although our results seem to encourage the adoption of an early endoscopic procedure to treat an acute presentation of pilonidal sinus, major limitations of our study have to be addressed. First of all, the retrospective design of the study and the relatively small sample size constitute limitations of the study. Furthermore, patients' satisfaction and return to normal activities have been evaluated without standardized questionnaires.

Another important aspect to be considered is the long-term follow-up.

In fact, considering a 5-year follow-up as the gold standard for the pilonidal sinus surgery, as previously described [21, 22], a small number of patients completed this follow-up period (8 in each group).

Finally, it is worth mentioning that endoscopic approach is not adopted in most institutions yet and the current literature is lacking of comparative studies between endoscopic and conventional incision of pilonidal abscess.

For the abovementioned reasons, further studies are needed to obtain definitive conclusions.

## Conclusions

Our results encouraged to perform VAAPS in case of an acute presentation of pilonidal sinus. Furthermore, surgeons have to take into account that an early endoscopic approach could be a safe and effective treatment.

**Author contributions** Manigrasso M, Milone M: conception, design, interpretation of the data, and drafting of the article; Velotti N, Sosa Fernandez LM, Vertaldi S, Maione F, Gennarelli N, Schettino P, Musella M: acquisition, analysis, and interpretation of the data; De Palma GD and Milone M: interpretation of the data and critical revisions; De Palma GD and Milone M: critical revisions and final approval.

**Funding** No funding has been received to perform this study.

## Compliance with ethical standards

**Competing interests** The authors declare that they have no conflict of interest.

**Informed consent statement** Informed consent was obtained from all individual participants included in the study.

## References

- Segre D, Pozzo M, Perinotti R, Roche B, Italian Society of Colorectal Surgery (2015) The treatment of pilonidal disease: guidelines of the Italian Society of Colorectal Surgery (SICCR). *Tech Coloproctol*. 19(10):607–613
- Steele SR, Perry WB, Mills S, Buie WD, Standards Practice Task Force of the American Society of Colon and Rectal Surgeons (2013) Practice parameters for the management of pilonidal disease. *Dis Colon Rectum* 56(9):1021–1027
- Allen-Mersh TG (1990) Pilonidal sinus: finding the right track for treatment. *Br J Surg* 77(2):123–132
- Jain Y, Javed MA, Singh S, Rout S, Joshi H, Rajaganeshan R (2017) Endoscopic pilonidal abscess treatment: a novel approach for the treatment of pilonidal abscess. *Ann R Coll Surg Engl* 99(2):134–136
- Javed MA, Fowler H, Jain Y, Singh S, Scott M, Rajaganeshan R (2016) Comparison of conventional incision and drainage for pilonidal abscess versus novel endoscopic pilonidal abscess treatment (EPAT). *Tech Coloproctol* 20(12):871–873
- Milone M, Fernandez LM, Musella M, Milone F (2016) Safety and efficacy of minimally invasive video-assisted ablation of pilonidal sinus: a randomized clinical trial. *JAMA Surg* 151(6):547–553
- Milone M, Velotti N, Manigrasso M, Milone F, Sosa Fernandez LM, de Palma GD (2019) Video-assisted ablation of pilonidal sinus (VAAPS) versus sinusectomy for treatment of chronic pilonidal sinus disease: a comparative study. *Updat Surg* 71(1):179–183
- Milone M, Velotti N, Manigrasso M, Vertaldi S, di Lauro K, de Simone G, Cirillo V, Maione F, Gennarelli N, Sosa Fernandez LM, de Palma GD (2020) Long-term results of a randomized clinical trial comparing endoscopic versus conventional treatment of pilonidal sinus. *Int J Surg* 74:81–85
- Milone M, Musella M, Di Spiezio SA, Bifulco G et al (2014) Video-assisted ablation of pilonidal sinus: a new minimally invasive treatment—a pilot study. *Surgery*. 155(3):562–566
- Milone M, Sosa Fernandez LM, Vertaldi S, De Simone G, et al (2020) Video-assisted ablation of pilonidal sinus - a video vignette. *Colorectal Dis*
- Milone M, Di Minno MN, Musella M, Maietta P et al (2013) The role of drainage after excision and primary closure of pilonidal sinus: a meta-analysis. *Tech Coloproctol* 17(6):625–630
- Apolone G, Mosconi P (1998) The Italian SF-36 Health Survey: translation, validation and norming. *J Clin Epidemiol* 51(11):1025–1036
- Meinero P, Mori L, Gasloli G (2014) Endoscopic pilonidal sinus treatment (E.P.Si.T.). *Tech Coloproctol* 18(4):389–392. <https://doi.org/10.1007/s10151-013-1016-9>
- Mendes CRS, Ferreira LSM, Salim L (2019) Brazilian and ARGENTINEAN MULTICENTRIC study in the surgical minimally invasive treatment of pilonidal cyst. *Arq Bras Cir Dig* 32(3):e1447
- Kalaiselvan R, Liyanage A, Rajaganeshan R (2020) Short-term outcomes of endoscopic pilonidal sinus treatment. *Ann R Coll Surg Engl* 102(2):94–97
- Emile SH, Elfeki H, Shalaby M, Sakr A, Giaccaglia V, Sileri P, Wexner SD (2018) Endoscopic pilonidal sinus treatment: a systematic review and meta-analysis. *Surg Endosc* 32(9):3754–3762
- Giarratano G, Toscana C, Shalaby M, Buonomo O, Petrella G, Sileri P (2017) Endoscopic pilonidal sinus treatment: long-term results of a prospective series. *JSLs*. 21(3):e2017.00043
- Iesalnieks I, Ommer A, Petersen S, Doll D, Herold A (2016) German national guideline on the management of pilonidal disease. *Langenbeck's Arch Surg* 401(5):599–609. <https://doi.org/10.1007/s00423-016-1463-7>
- Croke L (2019) Pilonidal disease management: guidelines from the ASCRS. *Am Fam Physician* 100(9):582–583

20. Johnson EK, Vogel JD, Cowan ML, Feingold DL, Clinical Practice Guidelines Committee of the American Society of Colon and Rectal Surgeons et al (2019) The American Society of Colon and Rectal Surgeons' clinical practice guidelines for the Management of Pilonidal Disease. *Dis Colon Rectum* 62(2):146–157
21. Doll D (2010) 5- and 10-year recurrence rate is the new gold standard in pilonidal sinus surgery benchmarking. *Med Princ Pract* 19(3):216–217
22. Milone M, Velotti N, Manigrasso M, Anoldo P, Milone F, de Palma GD (2018) Long-term follow-up for pilonidal sinus surgery: a review of literature with metanalysis. *Surgeon*. 16(5):315–320

**Publisher's note** Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.