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ORIGINAL ARTICLE

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A comparison of flap reconstruction vs the laying open technique or excision and direct suture for pilonidal sinus disease: A meta-analysis of randomised studies

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Abstract

Many treatments have been described for pilonidal disease, but recurrence cannot be completely eliminated. The aim of this study was to perform a meta-analysis of randomised, controlled trials comparing flap repair vs the laying open technique and/or excision and direct closure techniques in the treatment of chronic pilonidal sinus disease. The primary outcome measure was the recurrence rate. Secondary outcomes were complete wound-healing time, duration of the incapacity to work, quality of life and patient satisfaction, postoperative pain, wound infection, bleeding or haematoma, skin wound complications, and duration of hospital stay. Seventeen studies were included. The meta-analysis demonstrated a lower risk of recurrence, a shorter duration of incapacity to work, a lower risk of wound infections, a lower risk of skin wound complications, and a shorter duration of hospitalisation in favour of flap vs direct closure. A shorter time to complete wound healing and a shorter duration of incapacity to work for flap vs the laying open technique were observed.

Superiority of flap repair vs direct closure in pilonidal sinus treatment was demonstrated in this meta-analysis. These results suggest avoiding primary direct closure in clinical practice. Compared with the laying open technique, flaps result in faster healing and a shorter time to return to activities.

KEYWORDS

direct suture, laying open technique, meta-analysis, piloninal sinus, surgical flaps

1 | INTRODUCTION

Pilonidal sinus is an acquired condition that mainly affects young people. The concept of an acquired disease was developed by Patey and Scarff not long after the Second World War on the basis of the high incidence of recurrences and the sporadic onset of the disease in other areas of the body (inter-digital folds in the barber's hand).[1-4] During the Second World War, the disease gained significant importance because it occurred in many soldiers, nicknamed the "Jeep disease".[5] The main morbidity is frequent and disabling sinus infections that lead to severe pain and purulent discharge in healthy patients with an active professional life. Many eradication treatments have been described, ranging from open excision,[6] de-roofing,[7,8] marsupialisation,[5,9] and phenolisation[10-13] to excision and primary suture techniques

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and either median direct suture[14,15] or reconstruction of loss substances by local flaps.[16-24] However, no procedure can completely eradicate it. Laying open and direct suture are common surgical strategies used. They allow complete excision of the sinus, are easy to perform, and do not require special surgical training. The use of flap repair after the excision of pilonidal sinus has increased in recent decades. This makes it possible to place the suture outside the median line, the focus of the disease. This is particularly useful in cases of multi-recurrent and multi-fistular diseases. Nonetheless, it requires training in plastic and reconstructive surgery procedures.

Well-conducted, randomised, controlled, prospective studies comparing different techniques for this pathology are rare.[25-28] However, they are essential for the surgeon to make a decision on how to treat the disease, the primary aim being to avoid recurrence and generate the least possible perioperative morbidity.

The aim of this study was to perform a meta-analysis of published, randomised, controlled trials comparing flap repair after pilonidal sinus excision vs the laying open technique with secondary healing or vs median direct closure techniques in patients suffering from chronic pilonidal sinus disease.

Key Messages

- The primary aims of the surgical treatment of pilonidal disease are to avoid recurrence and generate the least possible perioperative morbidity
- Laying open, direct suture, and flap reconstruction are common surgical strategies used to eradicate pilonidal sinus
- This meta-analysis compares the results of flap reconstruction vs laying open excision and/or direct suture by including 17 randomised controlled trials
- Direct closure has to be avoided in favour of a technique that generates fewer recurrences
- Flap repair has significant advantages over laying open technique or excision, especially in terms of faster wound healing and shorter return to work

2 | METHODS

2.1 | Search strategy

Two independent reviewers (C.B. and B.C.) conducted a systematic review of related articles in the PubMed, Cochrane Library, and EMBASE databases. The reviewed articles were published between November 1998 and February 2018. The following association of keywords was used: “pilonidal” or “pilonidal disease” or “pilonidal sinus” or “pilonidal cyst” or “sacrococcygeal disease” with “flap” or “reconstruction” and with “randomised.”

We also did a manual search using citations from trials that were included and reviewed similar articles. There was no restriction regarding the countries in which the trial was performed. We also searched for ongoing trials using clinicaltrials.gov and the CenterWatch Clinical Trials listing service. The online search was supplemented with the bibliographies of identified articles to retrieve any other relevant published material.

2.2 | Inclusion criteria

Study selection was based on an initial screen of titles and abstracts, followed by a further screening of full texts. Eligible studies were English-language randomised controlled studies comparing flap reconstruction vs the laying open technique and/or direct closure for the treatment of chronic pilonidal sinus, with de novo and/or recurrent presentation, in patients aged 14 years or older. We excluded non-randomised studies, retrospective studies, studies concerning pilonidal abscess, and those on the paediatric population. Studies were included if they provided data on the recurrence rate (the primary endpoint of the meta-analysis).

We excluded studies that compared one type of flap or procedure vs another.

Descriptive data including study features (methods, participants, interventions, outcomes) and data on primary or secondary outcomes were then extracted independently. If original data were missing, we contacted the authors by email (twice). Reviewers' discrepancies were resolved after discussion and reaching consensus with the methodologist (E.B.).

2.3 | Outcome measures

The primary outcome measure was the recurrence rate. It was defined as the reappearance of symptoms after complete healing and an asymptomatic period. Secondary outcome measures were complete wound-healing time, duration of the incapacity to work, quality of life and/or patient satisfaction, postoperative pain, wound infection, bleeding or haematoma, skin wound complications, and duration of hospital stay. Wound-healing time was defined as the period of complete epidermisation with the stopping of wound care in case of an open excision and time for the removal of stitches in case of direct closure or flap repair. The duration of the incapacity to work was expressed in postoperative days and corresponds to the time to return to work. Skin wound

complications included any disruption of sutures and total or partial skin necrosis.

2.4 | Data extraction and quality assessment

Data extraction was performed using a standard data collection form. These data included: age and gender distribution, number of patient included in each group, number of losses to follow up, inclusion and exclusion criteria, primary and secondary endpoints, type of flap used, and follow-up data. For the subgroup analysis, Limberg flap, Z-plasty, Y-Y advancement, and rotation flap were considered transposition flaps, whereas the Karydakis flap was considered an advancement flap.

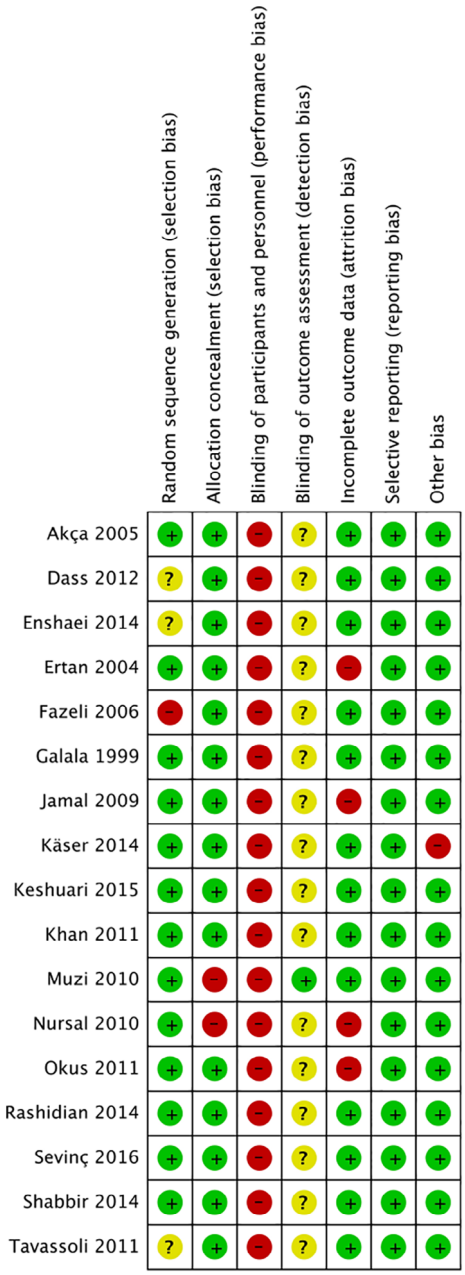

FIGURE 1 Summary of the risk of bias

The risk of bias of the studies that were included was scored using the Review Manager programme (Rev Manager 5.3) according the Cochrane tool (Figure 1).

2.5 | Statistical analysis

Study results were tabulated with the total number of subjects in flap vs the laying open technique or direct closure (using intention to treat or full analysis set), number of events for recurrence or postoperative complications, and mean together with SD for continuous endpoints. Missing SDs were assessed according to the sample size and means for reported *P*-values.[29] We calculated the risk ratio (RR) of recurrence (and postoperative complications) with flap vs the laying open technique or direct closure according to the inverse variance (IV) approach with their 95% confidence intervals (95% CI). When the number of postoperative complications was equal to zero in each group, it was imputed to 1 in order to estimate the RR. We estimated the mean differences between flaps and the laying open technique or direct closure for continuous endpoints according to the IV approach using their 95% CI. We also estimated the standardised mean differences (SMD) assessing quality of life or patient satisfaction.

To assess heterogeneity across studies, we used forest plots, as well as Cochran's heterogeneity statistic and Higgins I^2 coefficients.[30] A *P*-value <.1 or $I^2 > 50\%$ was considered suggestive of statistical heterogeneity, prompting random-effects modelling.[31] To minimise heterogeneity of the studies, when it was possible, subgroup analyses were also performed. We produced funnel plots to assess publication bias.[32]We used the Review Manager 5.3 analysis software (The Cochrane Collaboration, Copenhagen, Denmark) for all analyses.

3 | RESULTS

The literature search is illustrated in the flow chart of study selection (Figure 2). We included a total of 17 studies in the systematic review.

3.1 | Characteristics of the studies included

Seventeen randomised controlled studies,[33-49] involving 2215 cases, were included in the systematic review, and their characteristics are shown in Tables 1 and 2.

The population in all studies comprised patients presenting with chronic pilonidal sinus. Among them, 1083 patient underwent a flap procedure, 328 patients underwent a laying open procedure, and 804 patients underwent median direct closure. A total of 114 patients (5.1%) were lost to follow up. Because of reported protocol violations, 14 cases

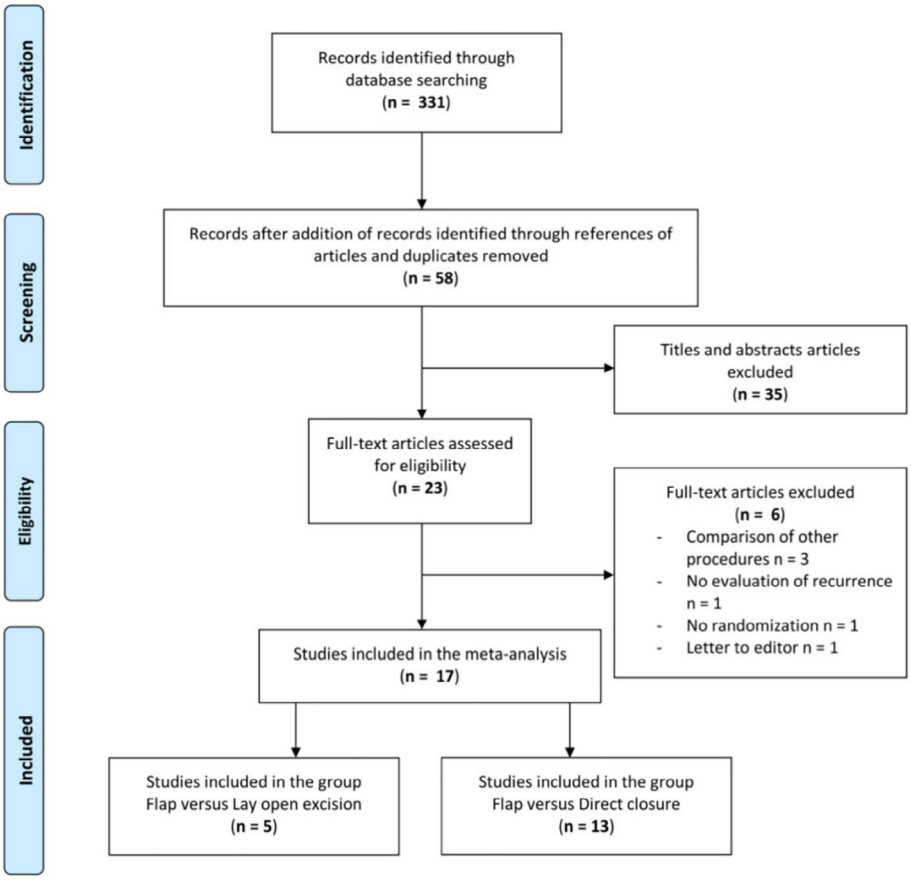

FIGURE 2 Flow chart of the study selection

were excluded from the study of Nursal et al.[39] No other violations of the study protocols were reported.

Methods of randomisation were detailed for most studies and included computer-generated randomisation or sealed envelopes and block randomisation. Blinding was not attempted for most studies.

Follow-up data from the studies ranged from 6 to 49 months.

The characteristics of the population that was included are presented in Table 3.

3.2 | Disease recurrence

All studies reported data on disease recurrence. The meta-analysis showed a trend towards a lower incidence of recurrent disease for flaps vs the laying open technique, with a risk ratio of 0.50, which, however, was not statistically significant ($P = .23$, 95% CI [0.16-1.56]) (Figure 3). Because of heterogeneity across the studies (I^2 52%), we carried out a subgroup analysis (Figure 4). This demonstrated a benefit in favour of advancement flaps vs the laying open technique (RR 0.17 [0.04-0.73], $P = .02$). However, it involved only the results of the study by Keshvari et al.[4] There was no significant difference between the transposition flap and the laying open technique ($P = .75$). The meta-analysis showed a lower risk of recurrence in favour of flaps vs direct closure, with an RR of 0.42 [0.21-0.85] ($P = .02$) (Figure 3).

3.3 | Time to complete wound healing

Results were given by the number of postoperative days. The meta-analysis demonstrated a significantly lower wound-healing time for flaps vs the laying open technique, with a mean benefit of 43.69 [72.60-14.79] days ($P = .003$) but no significant difference between flaps and direct closure ($P = .27$) (Figure 5).

3.4 | Duration of the incapacity for work

The meta-analysis demonstrated a significant difference in favour of flap vs other procedures ($P \leq .00001$), with a mean difference of 5.63 [10.87-0.40] days ($P = .03$), vs the laying open technique and 4.21 [6.26-2.16] days ($P < .0001$) vs direct closure (Figure 6).

3.5 | Quality of life and patient satisfaction

The meta-analysis showed no significant difference between flap and the laying open technique in terms of patient satisfaction ($P = .32$) (Figure 7). The meta-analysis showed a

TABLE 1 Characteristics of the studies that were included: flap vs laying open technique

	Study	No. of patients	Lost to follow up	Type of flap	Ratio flap: other	Inclusion criteria	Exclusion criteria	Primary endpoint	Secondary endpoints	Type of randomisation	Blinding	Follow up
Comparison flap vs laying open technique	Keshvari et al[35]	321	0	Karidakis flap	161:160	PSD		Pain, time to complete wound healing, time to return to work, patient satisfaction, recurrence rate, complications		Computer generated	Patient	Median 49 months
	Käser et al[34]	102	5	Limberg flap	51:51	PSD	Acute abscess, recurrent PSD, age < 18 years, lack of consent, immunodeficiency, pregnancy, dermatological disease	Time to return to work	Pain, complications, recurrence rate, patient satisfaction	Computer generated	No	12 months
	Fazeli et al[36] 2006	144	6	Z-plasty	72:72		Acute abscess	Pain, duration of hospital stay, time to return to work, complications, time to complete wound healing, recurrence rate			No	Mean 22 months
	Jamal et al[33]	49	4	Limberg flap	24:25	PSD	Lost to follow up	Pain, duration of hospital stay, complications, recurrence rate				Mean 18 months
	Rashidian et al[37]	60	0	Limberg flap	20:40	Primary PSD	Acute abscess, recurrent PSD	Duration of hospital stay, time to return to work, time to complete wound healing, recurrence rate, complications		Block randomisation		Mean 18 months

Abbreviations: DC, direct closure; PSD, pilonidal sinus disease.

TABLE 2 Characteristics of included studies: flap vs direct closure

	Study	No. of patients	Lost to follow up	Type of flap	Ratio flap: other	Inclusion criteria	Exclusion criteria	Primary end-point	Secondary end-points	Type of randomisation	Blinding	Follow up
Comparison flap vs direct closure	Ertan et al[38]	100	35	Limberg flap	50:50	PSD	Acute abscess	Duration of hospital stay, time to complete wound healing, time to return to work, complications, recurrence rate, quality of life and patient satisfaction, pain				Mean 19 months
	Nursal et al[39]	238	45	V-Y advancement flap	77:161	PSD	Acute abscess	Complications, recurrence rate, patient satisfaction, time to return to work				Mean 29.7 months
	Muzi et al[40]	272	12	Limberg flap	130:130	PSD	BMI > 35, diabetes, epilepsy, severe allergy to medication, social-familiar reasons, drug addiction	Time to complete wound healing	Pain, duration of hospital stay, time to return to work, complications, recurrence rate	Computer generated	No	Mean flap 45.74 months/ DC 47.83 months
	Sevinç et al[41]	150	0	Limberg flap, karydakis flap	100:50	Primary PSD	Recurrent PSD	Complications, recurrence rate		Closed envelopes	Patient	Median 24.2 months
	Tavassoli et al[42]	100	0	Limberg flap	50:50	PSD	Acute abscess, recurrent PSD, immunodeficiency, diabetes, age < 15 years or > 45 years, severe hirsutism in women, psychiatric disease or poor hygiene	Complications, pain, time to return to work, time to complete wound healing, recurrence rate, patient satisfaction				6 monthss
	Okuş et al[43]	93	0	Limberg flap	49:44	PSD		Complications, recurrence rate		Closed envelopes		Median 29.5 months
	Galala et al[44]	46	0	Limberg flap	24:22	PSD	Acute abscess, recurrent PSD	Complications, time to return to work, duration of hospital stay, recurrence rate		Closed envelopes		Mean 18 months
	Akca et al[45]	200	0	Limberg flap	100:100	PSD	Recurrent PSD, contraindications of general anaesthesia	Pain, duration of hospital stay, complications, time to return to work, recurrence rate		Computer generated		Median Flap 28 months/DC 29 months
	Shabbir et al[46]	60	0	Limberg flap	30:30	PSD	Recurrent PSD, age < 13 years	Complications, recurrence rate, duration of hospital stay, time to return to work				12 months

(Continues)

TABLE 2 (Continued)

Study	No. of patients	Lost to follow up	Type of flap	Ratio flap: other	Inclusion criteria	Exclusion criteria	Primary end-point	Secondary end-points	Type of randomisation	Blinding	Follow up
Dass et al[47]	80	0	Limberg flap	40:40	PSD	Recurrent PSD, acute abscess	Complications, pain, time to return to work, duration of hospital stay, recurrence rate				36 months
Khan et al[48]	120	0	Limberg flap	60:60	Primary PSD		Duration of hospital stay, complications, time to return to work, recurrence rate		Computer generated		24 months
Enshaei et al[49]	80	0	Rotation flap	40:40	Primary PSD	Acute abscess, recurrent PSD, diabetes, or obesity	Duration of hospital stay, pain, complications, recurrence rate, time to complete wound healing				6 months
Rashidian [37]	60	0	Limberg flap	20: 40	Primary PSD	Acute abscess, recurrent PSD	Duration of hospital stay, time to return to work, time to complete wound healing, recurrence rate, complications		Block randomisation		Mean 18 months

Abbreviations: DC, direct closure; PSD, pilonidal sinus disease.

trend towards a better quality of life and patient satisfaction for flap vs direct closure, with a mean difference of 0.19 [«−0.02» – 0.39], which, however, was not statistically significant (P = .07) (Figure 8).

3.6 | Postoperative pain

The meta-analysis showed no significant difference between flap and other procedures in terms of postoperative pain (P = .54) (Figure 8).

3.7 | Complications

- General rate of complications

The meta-analysis showed a significantly lower general rate of complications in favour of the flap vs the laying open group (RR = 0.57 [0.39-0.83], P = .004) but no significant difference between flap and direct closure (P = .65)(Figure 9).

- Wound infection

The meta-analysis showed no significant difference between flap and the laying open technique (P = .57) but a significant reduction in the risk of wound infections in favour of flap vs direct closure with a risk ratio of 0.37 [0.25-0.55] ($P < .00001$) (Figure 10).

- Bleeding and haematoma

The meta-analysis showed no significant difference between flap and other procedures in terms of the rate of haemorrhagic events (P = .96) (Figure 11).

- Skin wound complications: dehiscence and skin necrosis

The meta-analysis demonstrated a significantly higher risk of dehiscence and skin necrosis for flap vs the laying open technique (RR = 8.83 [1.98-39.29] (P = .004) (Figure 12). The subgroup analysis for flap vs open excision showed a significantly higher risk of wound complications for advancement flaps (RR = 12.72 [1.55-104.35], P = .02)[4] and a trend towards an increase in wound complication rate for transposition flaps (RR = 6.09 [0.73-50.72], P = .09) (Figure 13). The meta-analysis demonstrated a significantly lower risk of wound complications for flap vs direct closure with a risk ratio of 0.43 [0.28-0.66] (P = .0001) (Figure 13).

3.8 | Duration of hospital stay

The meta-analysis showed a longer duration of hospitalisation for flap vs the laying open technique, with a

TABLE 3 Characteristics of the populations that were included

Study	Type of surgery	Median age (years)				Gender	
		Mean	Median	SD	Range	Male (%)	Female (%)
Keshvari et al[35]	All		24		16-60	77.90%	22.10%
Fazeli et al[36]	All						
Käser et al[34]	Flap		26		18-25	84%	16%
	Open		24		18-52	78%	22%
Jamal et al[33]	Flap	26.04			19-37	87.50%	12.50%
	Open	26.84			19-37	96%	4%
Rashidian et al[37]	All	27.61			14-49	78.30%	21.70%
Ertan et al[38]	Flap	28		± 7.7		92%	8%
	Direct closure	26.3		± 6.8		90%	10%
Nursal et al[39]	All	26.2		± 8.2		79.40%	20.60%
Muzi et al[40]	Flap	25.05		± 7.53		88%	12%
	Direct closure	25.01		± 8.58		84%	12%
Sevinç et al[41]	All		24		18-47	82%	18%
Tavassoli et al[42]	All	24		± 4.35	16-36	80%	20%
Okuş et al[43]	Flap		24		17-33	97.90%	2.10%
	Direct closure		25.5		17-43	90.90%	9.10%
Galala et al[44]	Flap	23			17-30	80%	20%
	Direct closure	21			18-34	80%	20%
Akca et al[45]	Flap	26			15-60	85%	15%
	Direct closure	28			17-43	83%	17%
Shabbir et al[46]	Flap					90%	10%
	Direct closure					93.30%	6.70%
Dass et al[47]	All	28.4		± 8.6	16-48	92.50%	7.50%
Khan et al[48]	Flap	24			17-42	88.30%	11.70%
	Direct closure	26			16-40	85%	15%
Enshaei et al[49]	Flap	24.17		± 6.05	15-40	72.50%	28%
	Direct closure					55%	45%

mean difference of 0.98 [0.28-1.68] days ($P = .006$) but a shorter duration of hospitalisation vs direct closure with a benefit of 1.87 [2.88–0.85] days ($P = .0003$) (Figure 14).

3.9 | Study bias

Funnel plots showed no evidence of publication bias in this meta-analysis.

4 | DISCUSSION

After surgery for pilonidal disease, the risk of disease recurrence is lower with flap repair than with direct midline closure. The same results were found 10 years ago in the meta-analysis conducted by McCallum et al., including five trials that compared midline closure (corresponding to direct closure in our study) and off-midline closure (corresponding to flap repair in our study).[25] We included 13 studies that compared flap vs direct closure, which is three times higher than the number of studies included McCallum, and we confirmed their results. These results can be compared with those of two other meta-analyses that contrasted different modalities of closure, especially midline versus off-midline: that of Enriquez et al. in 2014 with 10 randomised prospective studies[26] and that of Horwood et al. in 2011 with 6 studies.[27] The findings were a significant decrease for one and a non-significant decreasing trend for the other in terms of the risk of recurrence in favour of the off-midline procedure.

We found no significant difference but rather a trend towards fewer recurrences in favour of flaps vs open excision. With only five randomised prospective studies

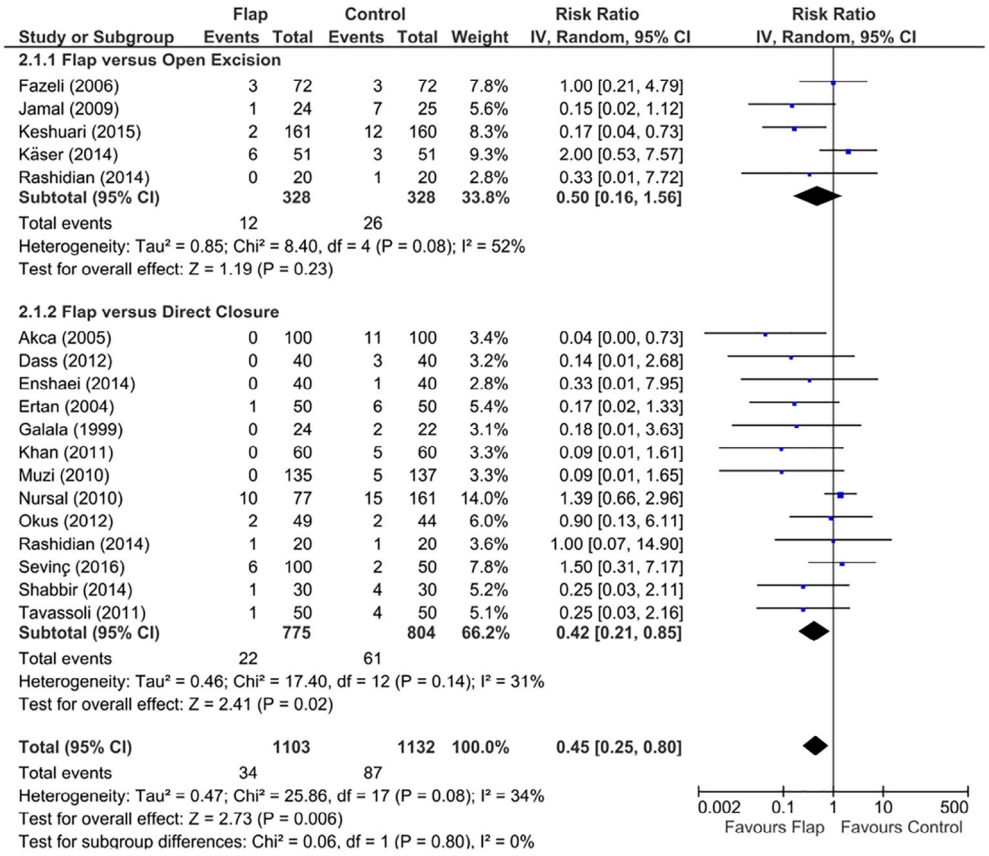

FIGURE 3 Forest plot of the recurrence rate

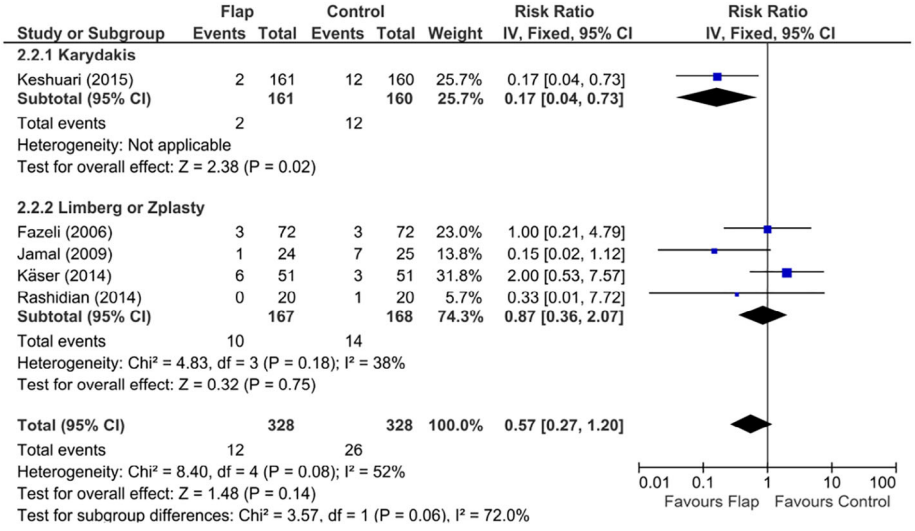

FIGURE 4 Forest plot of the recurrence rate by flap (for flap vs open excision)

comparing these two techniques, it is possible that we were underpowered to demonstrate a benefit in favour of flap repair. The same results were shown by McCallum et al. in 2008.[25] The lack of randomised prospective studies comparing the laying open technique vs flap repair makes it difficult to rule in favour of either of these two surgical techniques. Nevertheless, our subgroup analysis showed a benefit in favour of advancement flap vs the laying open technique. Although It involved only results of one study,[35] it included a significant number of patients (321 patients), which gives it a significant statistical importance.

The wound-healing time was shorter in flap procedure vs open excision, but there was no significant difference vs direct closure. These results appear logical because open excision involves a secondary intention healing by granulation, which is much slower than the usual healing time for a closed scar. Healing by secondary intention can take up to several months.

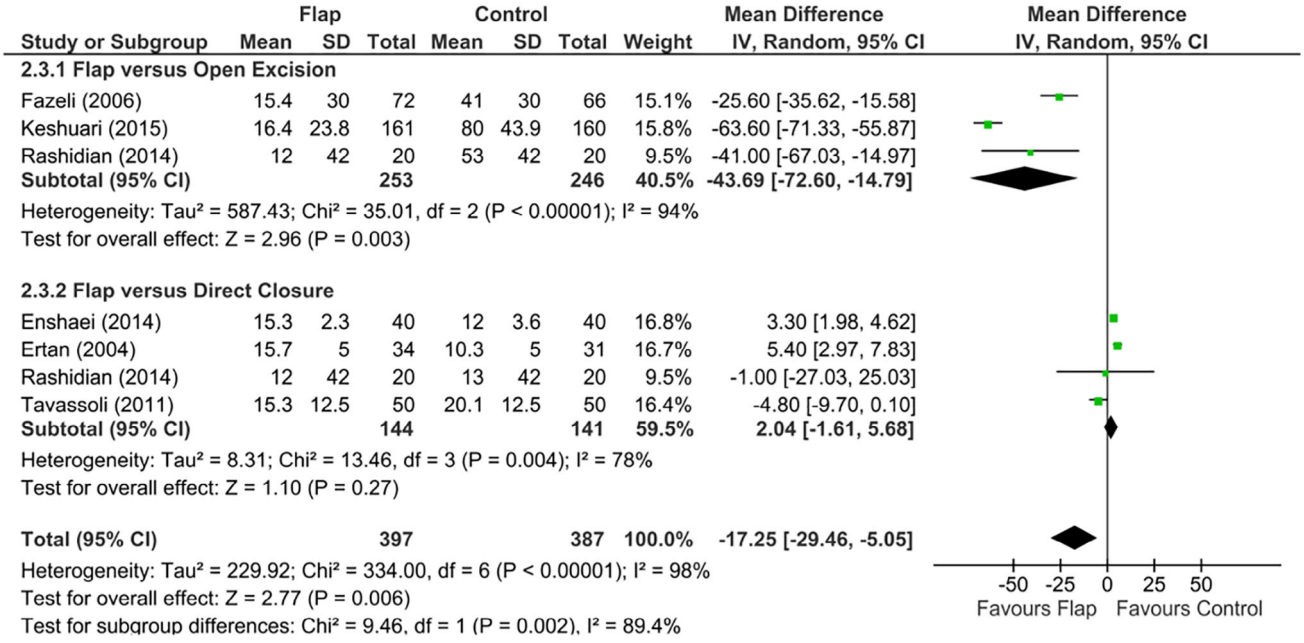

FIGURE 5 Forest plot of the time to complete wound healing (in days)

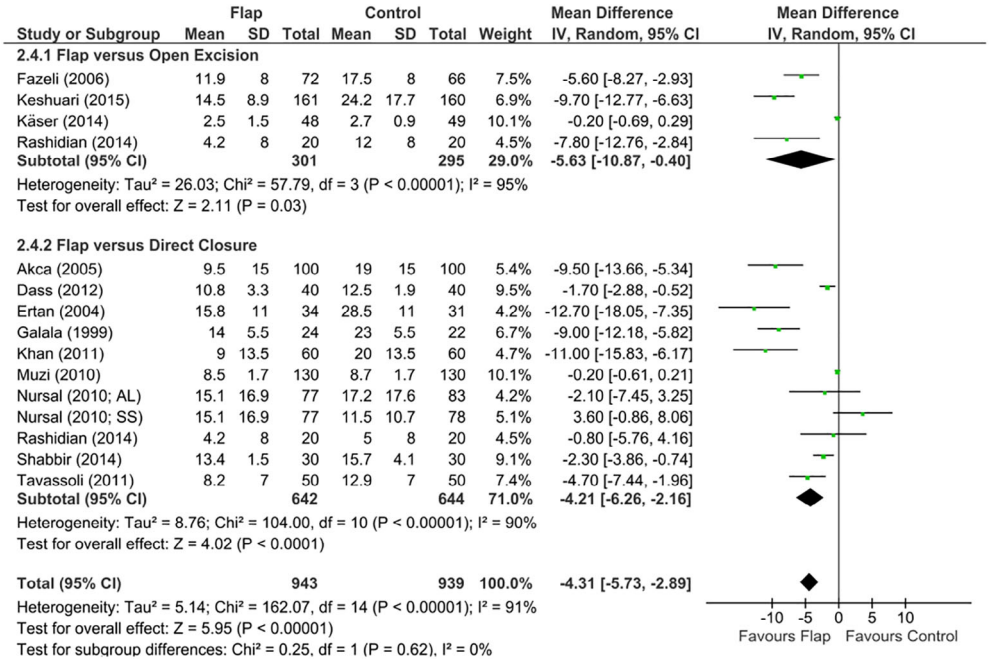

FIGURE 6 Forest plot of the duration of the incapacity to work (in days). In Nursal et al[39], AL is all layers and SS is subcutaneous suture

The general rate of complications was reduced in case of flap reconstruction vs open excision. This result appears incongruous with regard to the lack of increase in haemorrhage, infectious or skin/wound complications for the laying open technique vs flap. It can be explained by the fact that two studies[33,45] evaluating this global rate took into account delayed healing of the skin over 3 months at this rate.

We found a lower risk of wound infection after flap than after direct closure. These results are similar to the three previous meta-analyses for this outcome.[25-27]

Wound complications were significantly higher for advancement flaps vs open excision. This underlies the risk of suture disruption that is also present in case of flap reconstruction, even though this risk is much lower in comparison with direct closure. This can be explained by excessive tension on the suture in case of direct closure, whereas flap procedure tension is more homogeneously distributed with the recruitment of adjacent trophic tissues. Once again, all these results encourage the cessation of the direct closure technique in the surgical management of pilonidal disease.

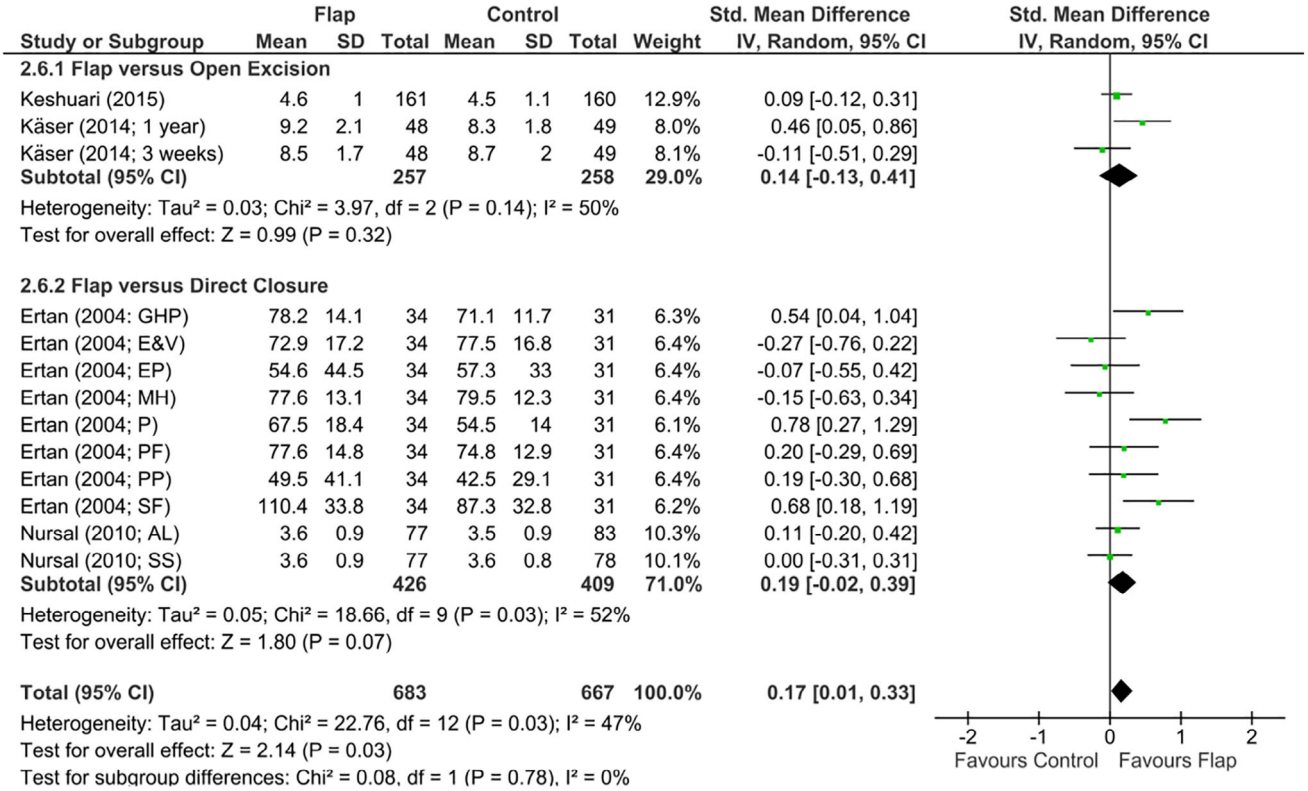

FIGURE 7 Forest plot of the quality of life and patient satisfaction. For quality of life evaluated using Cardiff Wound Impact Schedule scores (Ertan et al[38]) : GHP, general health perception; PF, physical functioning; SF, social functioning; PP, role limitation because of physical problems; EP, role limitation because of emotional problems; P, pain; E&V, energy and vitality; MH, mental health. In Nursal et al[39], AL, all layers; SS, subcutaneous suture

Patients who had flap reconstruction returned to work more quickly, in a mean of 3 to 6 days earlier, than those with direct closure or the laying open technique. This implies that the invalidity caused by flaps was reduced in comparison with other procedures, allowing an earlier return to a professional activity and to other activities of daily living. According to Enriquez et al.[26] and Horwood et al.,[27] who compared off-midline closure with median midline closure, the same results were found in favour of the flap technique. We carried out the first meta-analysis that showed significantly less time to return to work in case of flap vs the laying open technique. Through extrapolation, we can assume that costs associated with sick leave following surgery are reduced in case of flaps in comparison with other procedures. This could be a public health benefit.

The duration of hospitalisation was reduced in case of flaps vs direct closure. These data are difficult to explain because a flap often requires more monitoring. However, because of some excessive tension that could be generated by direct closure, greater caution was taken when surveying and discharging the patient. Frequent suture disruption and infections after direct closure are also likely to increase the duration of hospitalisation.

More recently, Stauffer et al. have proposed a meta-analysis, merged data analysis, and comprehensive study on the recurrence of pilonidal sinus disease treated by common surgical procedures.[28] The strength of this study is the number of procedures and patients included, which gives a global picture of the rate and time of recurrence according to the procedure used. Its limitation is that non-randomised controlled trials have been included, reducing the statistical impact of the findings. For example, at five postoperative years, Bascom and Karydakis flaps have been found to lead to less recurrence than the laying open technique, which leads to less recurrence than primary midline closure, in their analysis of randomised controlled trials. Regarding the analysis of non-randomised controlled studies, there was also less recurrence with Karydakis, Bascom, and Limberg flap reconstruction in comparison with open and limited excision techniques, which in turn resulted in less recurrence than the direct closure. Many other common procedures are also compared, finding overall higher rates of early and late recurrence for other surgery than flap reconstruction or laying open excision.

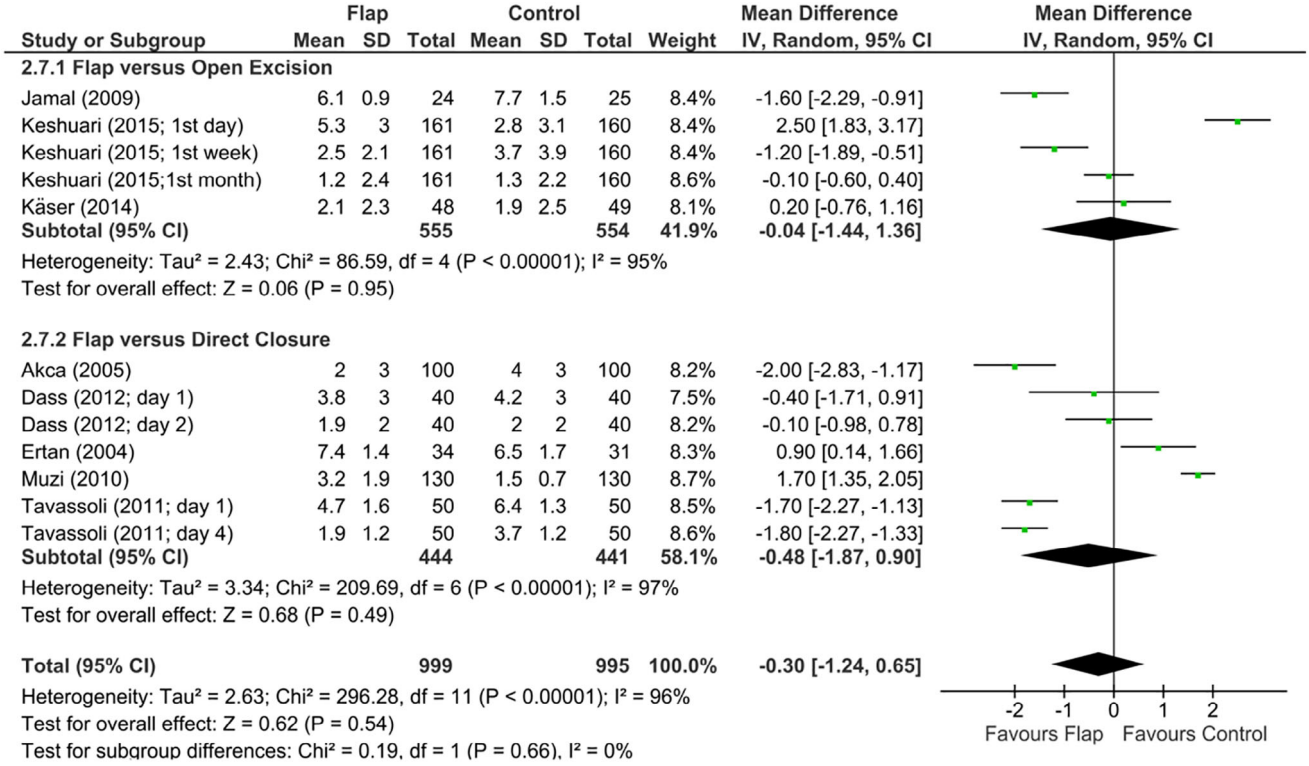

FIGURE 8 Forest plot of the postoperative pain (Visual Analogue Scale)

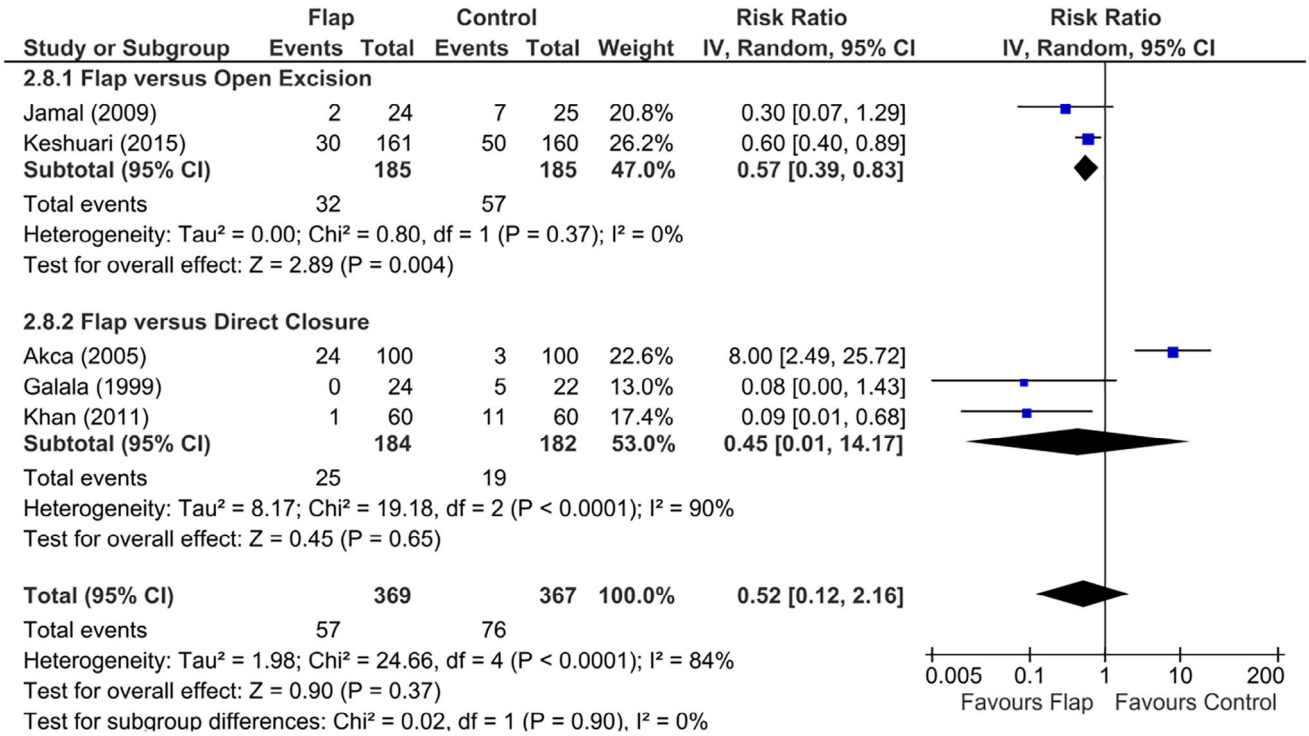

FIGURE 9 Forest plot of the general rate of complications

5 | LIMITATIONS

We included studies comparing different types of flaps to open excision and direct closure. Each type of flap has its own rate of complication and failure, with some flaps more reliable than others, particularly in terms of skin wound complications (skin necrosis and skin dehiscence). In addition, flap reconstruction is more successful in some

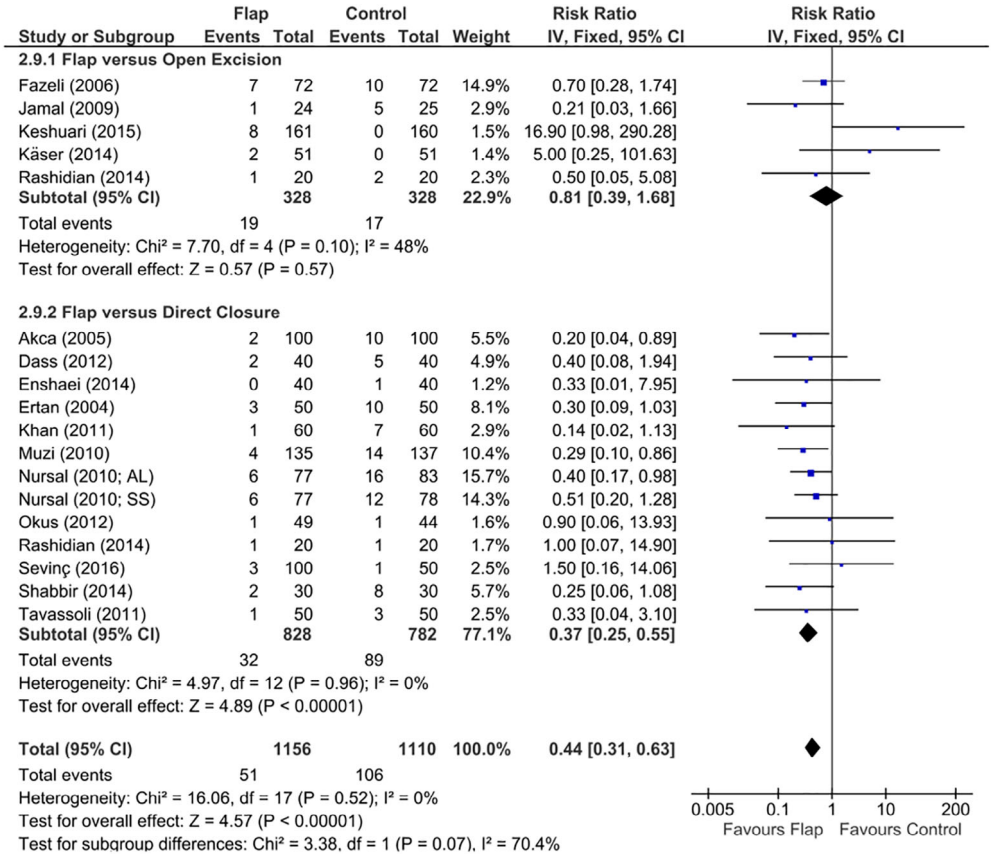

FIGURE 10 Forest plot of wound infections

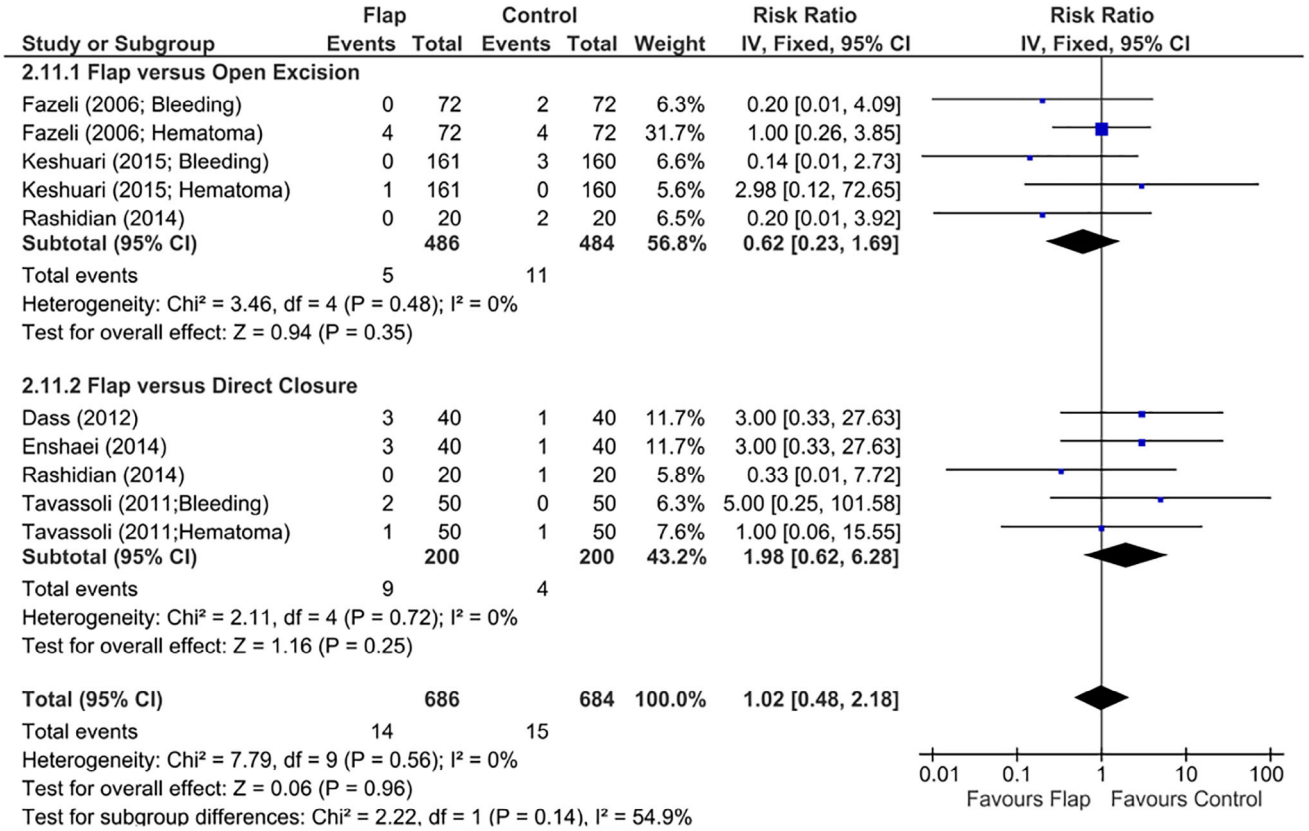

FIGURE 11 Forest plot of bleeding or haematoma

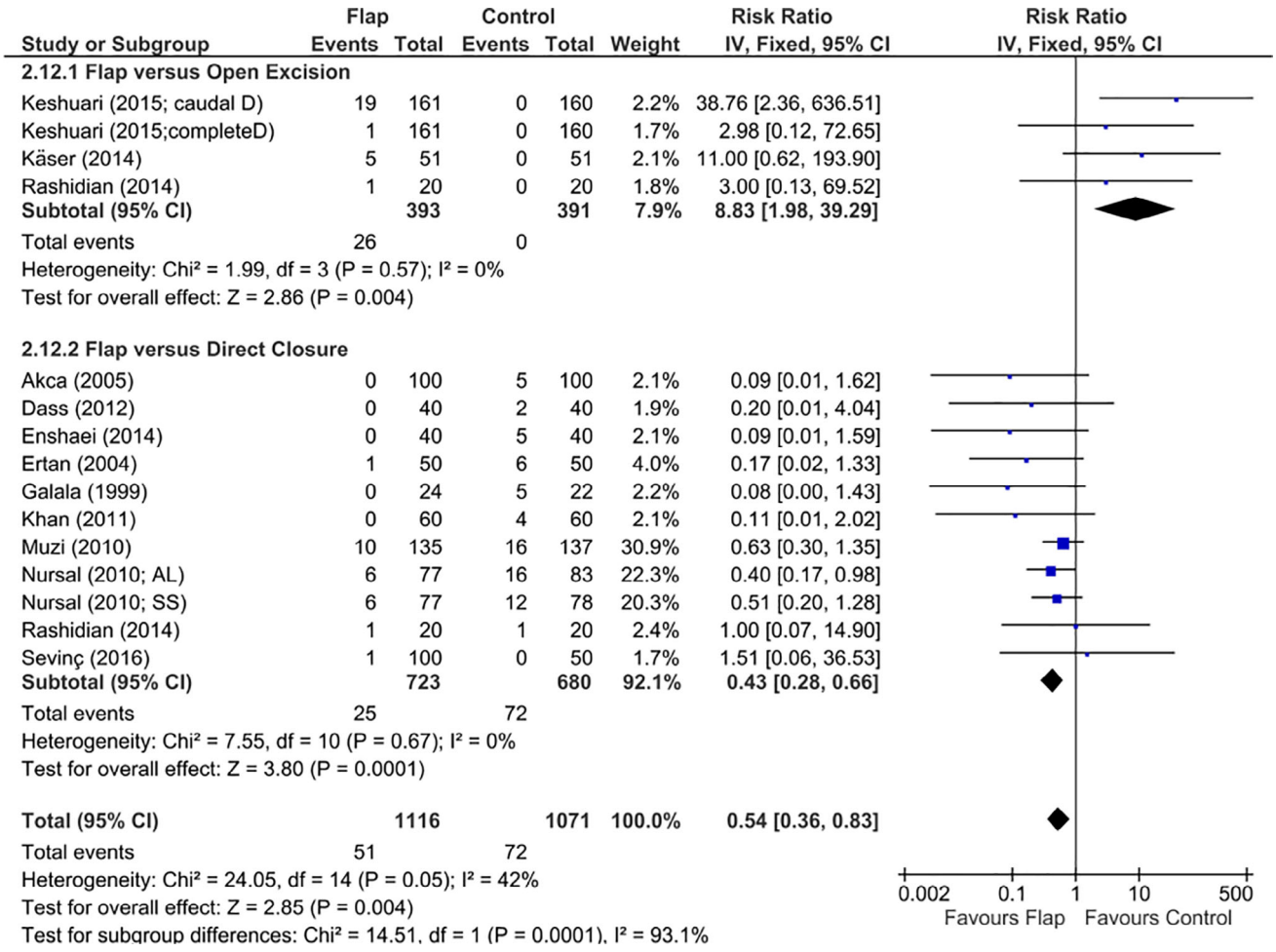

FIGURE 12 Forest plot of skin wound complications

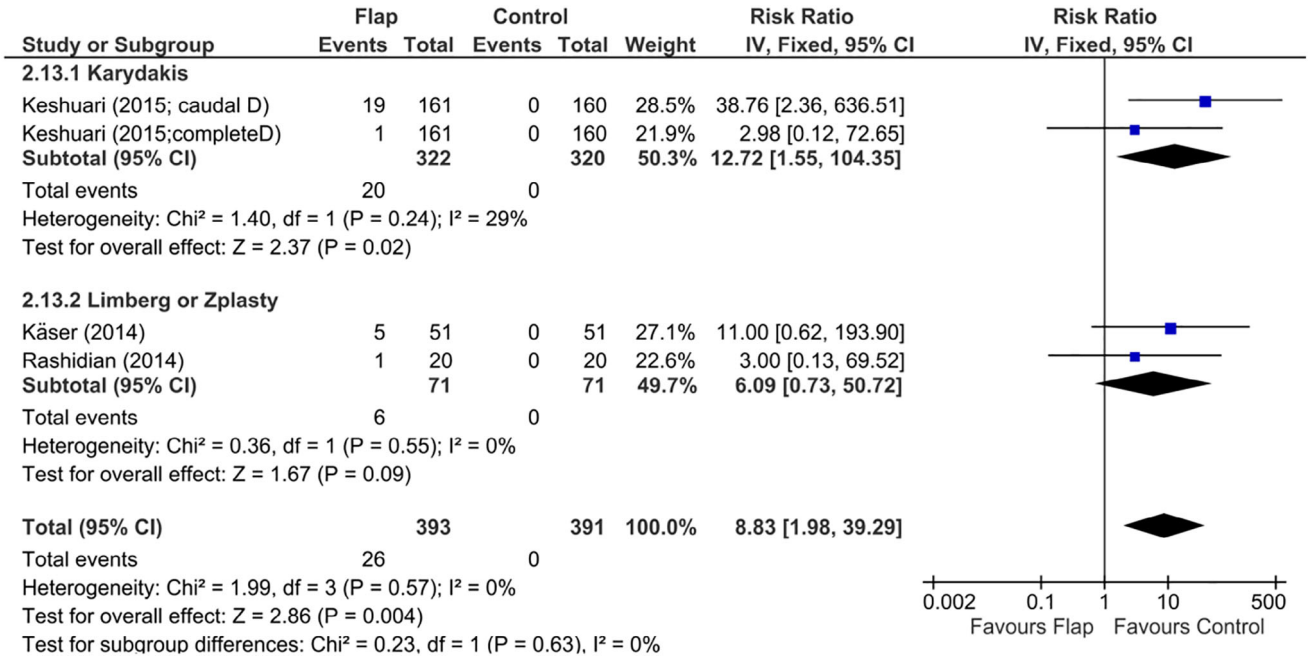

FIGURE 13 Forest plot of skin wound complications by flap (for flap vs open excision)

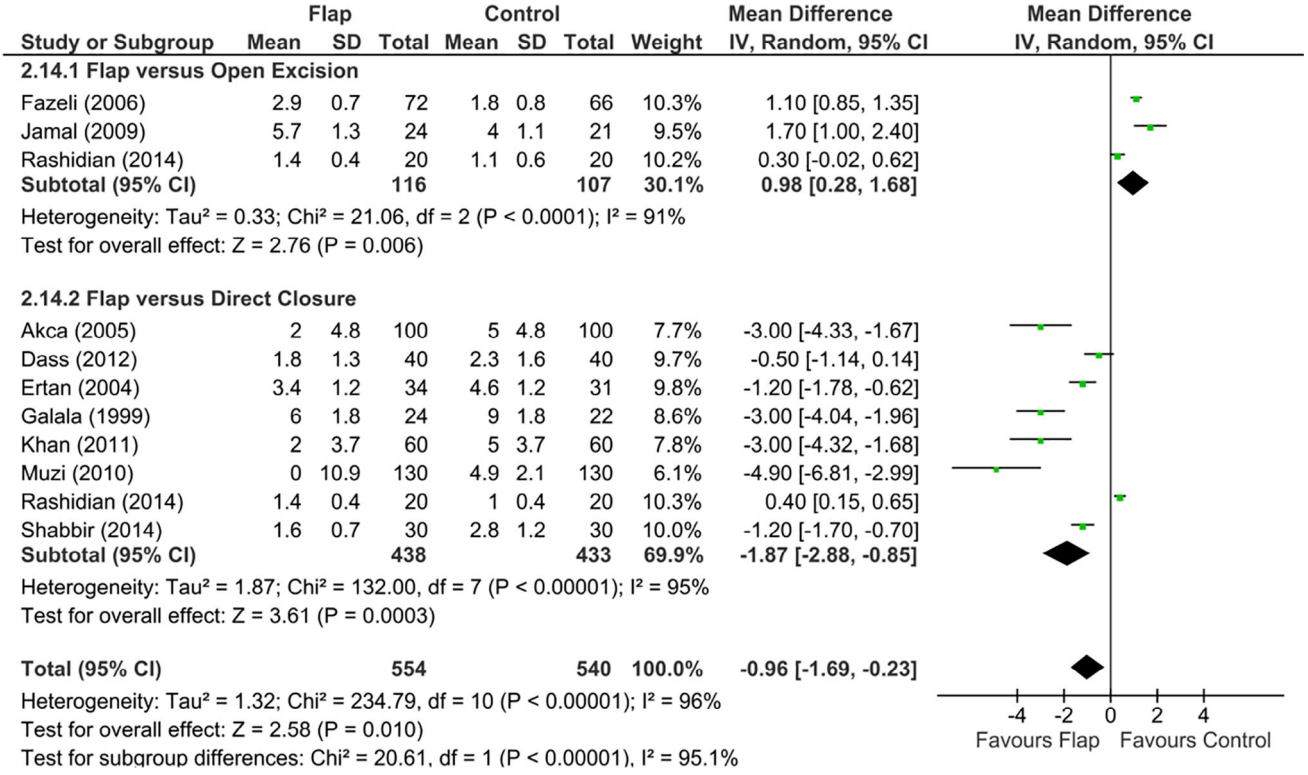

FIGURE 14 Forest plot of the duration of hospital stay (in days)

surgeons' hands than others. Reconstructive surgeons have specific and adequate training in flap reconstruction. However, pilonidal disease is mostly managed by general surgeons who are less experienced in flap surgery. Lack of training can lead to a higher complication rate than in the studies that were included.

Mean follow up was heterogeneous among the studies, with the longest follow up at 49 months and the shortest at 6 months. Late recurrence was poorly represented in the studies, and the late recurrence rate may be underestimated.

Most included studies exclude recurrences. Only two studies[33,36] in the laying open technique group and three studies[38-40] in the flap group vs direct closure did not exclude recurrences. Most other included studies excluded recurrences, and for three studies,[35,43,48] no precise information was provided on exclusion factors. Thus, the population of patients with a recurrent pilonidal cyst may have been under-represented in our meta-analysis. As the recurrence itself is a risk factor for further recurrence, the recurrence rates we obtained may have potentially been underestimated.

The heterogeneity was high among the studies included in our meta-analysis, particularly in terms of the number of patients included, duration of follow up, exclusion criteria, and scales of quality-of-life assessment. It could represent a limit in the interpretation of our results.

We have excluded pilonidal abscess because complete removal of the cyst should not be performed during the inflammatory phase. Oedema and acute inflammation would impede the exhaustive delimitation of the wall region concerned, particularly paramedian fistulas. Surgical drainage of the abscess will allow the reduction of acute inflammation in a few weeks, allowing better identification of the fistula system during excision surgery, which will be performed at distance from any abscess.[50] Some authors recommend placing the incision in a paramedian axis[51] or associating curettage of the cyst[52,53] in order to limit the risk of recurrence. Here, again, treatment is not consensual and could be studied.

5.1 | Implications for current practices

In view of the recurrence rate and postoperative morbidity, direct closure should be avoided.

Flap repair had significant advantages over laying open excision, especially in terms of faster wound healing and shorter return to work. This technique could be favoured, and surgeons should be trained to perform flap surgery.

5.2 | Implications for research

Pilonidal disease affects a young and active population, incurring costs in terms of hospitalisation, sick leave, and home nursing care. Economic studies that take into account the costs of hospital stay, duration of home care, and

duration of sick leave are necessary to choose between flap repair and the laying open technique.

6 | CONCLUSION

In light of superiority of flap repair vs direct closure in terms of a lower recurrence rate and fewer postoperative wound infections, we should completely avoid the direct primary closure technique. Compared with the laying open technique, the superiority of flap repair has not yet been proven. However, it had the advantages of faster healing and a shorter time to return to work and normal activities.

CONFLICT OF INTEREST

The authors declare no potential conflict of interest.

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