



# Evaluation of the efficacy of the Z-plasty surgical technique vs. secondary wound healing mechanism in the treatment of the pilonidal sinus: a clinical trial.

SA Vejdan, MD<sup>a,b</sup>, HA Danesh, MD<sup>d,e</sup>, F. Amirian, MD<sup>c</sup>, Z. Amirian, MD<sup>d,f,\*</sup>

**Background:** The most important step in treating a pilonidal sinus is eradication by surgical excision. Over the years, various surgical techniques have been reported for wound closure, yet their management still poses a challenge. The current study compares the results of two different methods of wound management: secondary wound healing versus the Z-plasty surgical technique.

**Material and method:** The current clinical trial recruited 84 uncomplicated pilonidal sinus patients who were to undergo complete surgical excision of the pilonidal sinus. For wound healing, the 84 subjects were equally divided into two groups of 42 patients each. One group was selected for Z-plasty surgical wound closure and the other for the secondary healing mechanism. Outcomes measured consisted of demographic data, length of operation, complications, severity of pain, number of dressings, recurrence, and complete healing time.

**Result:** Age or sex distribution and the median BMI (kg/m<sup>2</sup>) did not significantly differ between the two groups. The length of the operation for Z-plasty subjects was significantly longer ( $P < 0.0001$ ). The median number of dressing changes for secondary wound healing patients was 38.69, which was significantly higher than the 4.95 dressing changes for the Z-plasty group. The total time recorded for complete wound healing was  $21.61 \pm 4.27$  days in the Z-plasty group and  $41.23 \pm 24.28$  days for secondary wound healing subjects, which was statistically significant. Twenty-four hours postoperation, patients in the secondary wound healing group had significantly more pain, and the Visual Analogue Scale scores of the Z-plasty and secondary wound healing groups were  $3.42 \pm 0.76$  and  $6.09 \pm 1.2$ , respectively. Concerning the recurrence rate, there were no significant differences between the two groups. SPSS version 22 performed the analyses, and the independent  $t$ -test compared the continuous variables. A  $P$  value less than 0.05 was considered statistically significant.

**Conclusion:** Z-plasty is a safe and effective procedure in terms of wound complications and recurrence rate. This method is also cost-effective and better received by patients.

**Key words:** Pilonidal sinus, secondary healing, Z-plasty

## Background

In recent years, treatment for pilonidal sinuses has undergone many changes and has moved toward nonsurgical methods. However, in most surgical centres, surgery remains the major

<sup>a</sup>University of Medicine, Birjand, <sup>b</sup>Imam Reza Hospital, <sup>c</sup>Faculty of Medicine, Department of Internal Medicine, Mashhad University of Medical Sciences, Mashhad, <sup>d</sup>University of Medicine, <sup>e</sup>Clinical Immunology Research Center at Zahedan University of Medical Science, Zahedan and <sup>f</sup>Imam Ali Hospital, Meshginshahr, Iran

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\*Corresponding author. Address: General Surgeon at University of Medicine, Zahedan, Iran. Master of Trauma And General Surgery Wards, Imam Ali Hospital. Address: General Surgery Unit, Imam Ali Hospital Health St, Zahedan, Sistan & Baluchestan, Iran. Tel.: +985 433 295 571; fax: +98 915 597 8672. E-mail: Dr.bza66@yahoo.com (Amirian. Z).

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## HIGHLIGHTS

- Over the years, a wide variety of surgical techniques have been reported for wound closure in the treatment of a pilonidal sinus by surgical excision. Yet their management still poses a challenge. The current study compares the results of two different methods of wound management: secondary wound healing versus the Z-plasty surgical technique.
- The current clinical trial recruited 84 uncomplicated pilonidal sinus patients who were to undergo complete surgical excision of the pilonidal sinus.
- Twenty-four hours postoperation, patients in the secondary wound healing group had significantly more pain, and the Visual Analogue Scale scores of the Z-plasty and secondary wound healing groups were  $3.42 \pm 0.76$  and  $6.09 \pm 1.2$ , respectively. There were no significant differences between the two groups concerning the recurrence rate.
- Z-plasty is a safe and effective procedure in terms of wound complications and recurrence rate. This method is also cost-effective and better received by patients.

approach to patient treatment or at least a part of it. The first stage of surgical treatment is complete surgical excision, which is widely accepted by almost all surgeons and is not up for debate in

the context of the present paper. The surgery removes all tissues containing sinus tracts up to the sacrococcygeal bone. Management of the wound after excision is the remaining challenge. There are a number of surgical and nonsurgical management methods, each with its own advantages and drawbacks<sup>[1]</sup>.

The different approaches to wound management after surgical excision of a pilonidal sinus can be categorized into four main groups: secondary wound healing, midline closure, oblique or asymmetric closure, and full-thickness flaps<sup>[1]</sup>. Secondary wound healing is the oldest and most commonly used method, especially in less developed countries like Iran. Because it is easily applied, requires no particular technique, and requires no special post-surgery care since, in many small towns, it is hard to have professional healthcare access. Also, it is believed to have the lowest recurrence rate when compared to other methods<sup>[2]</sup>. On the other hand, secondary wound healing is also associated with more patient discomfort and pain in addition to a longer course of wound healing. Because this method requires more medical observation and care of the wound, its final cost is higher. Furthermore, delayed healing will extend the patient’s medical leave from work<sup>[1,3]</sup>. Primary wound closure and midline suturing have been the most commonly performed surgical procedures. Midline suturing has been associated with early failure in wound healing and a high recurrence rate. To address this, “off-midline” techniques were introduced. Asymmetrical or oblique incisions, such as the Karydakias flap<sup>[4,5,1]</sup> the Bascom procedure, and other oblique incisions, cover and lateralize the defect and the natal cleft. This leads to a faster healing process and a lower-than-median recurrence rate.

Full-thickness flaps (Limberg flap, Dufourmentel flap, VY-plasty and Z-plasty technique) were later recommended for wound closure<sup>[1]</sup>. Z-plasty is a surgical technique for the primary closure of pilonidal sinus wounds. It achieves the purpose of successfully altering the regional anatomy by flattening the natal crease. This reduces the recurrence rate and recovery time. The Z-plasty technique also creates a tension-free closure that minimizes postoperative pain<sup>[6]</sup>. Possible complications consist of tissue necrosis, early wound healing failure, infection, wound dehiscence, paraesthesia over the flap, seroma or haematoma formation<sup>[3,6,7]</sup>. Since the introduction of this method, many studies have investigated the efficacy and safety of Z-plasty. Most results have been in favour of this technique<sup>[3,6,8-16]</sup>.

This current clinical trial compares the results of two methods for pilonidal wound closure, namely, the secondary wound healing mechanism and the Z-plasty surgical technique.

### Materials and methods

The current research is a randomized clinical trial [balance block randomization (1:1) in parallel groups] and has been reported in line with the CONSORT criteria.<sup>[17]</sup>

Eighty-six patients were selected in a period of one year (2017/08/23–2018/08/23) (Fig. 1) teenagers and adults (ages 16–33 years) suffering from a class A pilonidal sinus based on the Awad *et al.*<sup>[18]</sup> classification, which was based on patient history and physical examination.

The study population included all the patients who were subjected to this procedure in this period of time.

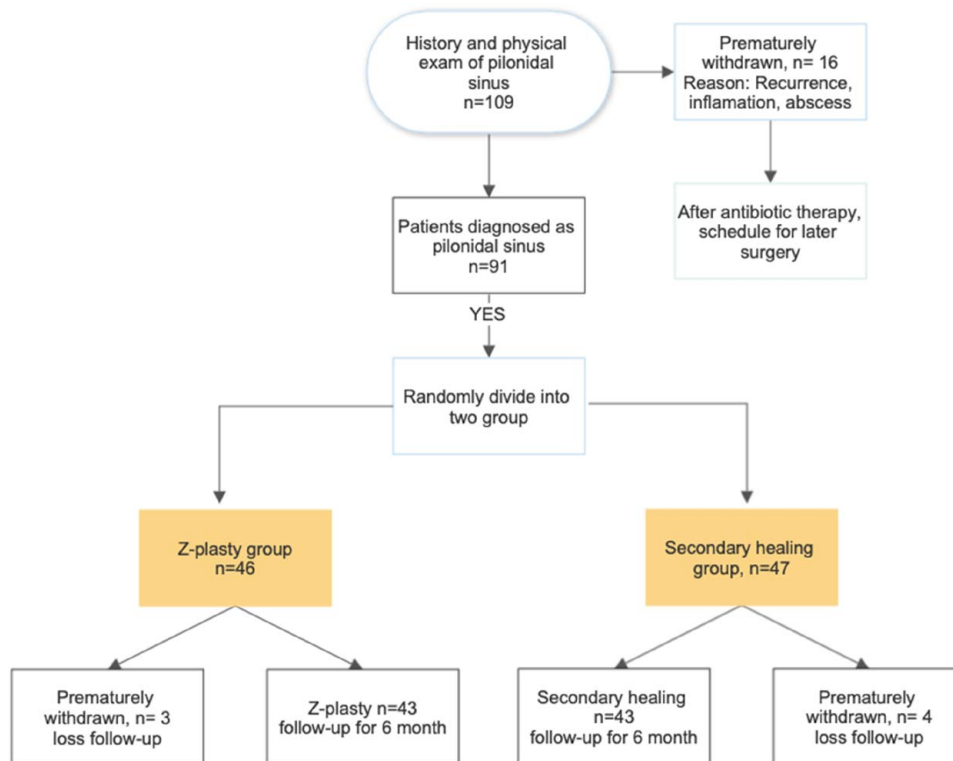


Figure 1. Flowchart of patients in this study.

After surgical excision, the 84 trial subjects underwent one of two methods of wound closure: (1) the Z-plasty surgical technique or (2) the nonsurgical secondary wound healing mechanism. The eligibility criteria were (1) patients with an uncomplicated pilonidal sinus, (2) BMI less than 30, (3) no history of conditions that interfere with wound healing, such as diabetes, smoking, cancer, chemo-radiotherapy, or corticosteroid, and (4) age between 15 and 35 years. The exclusion criteria included (1) a history of recurrence and previous pilonidal surgery, (2) any forms of infection, such as pilonidal abscess or cellulitis, (3) drug abusers, and (4) no interest in participating in the postoperative follow-up program. Based on these criteria, the total number of patients was 84, divided into two groups of 42. The study's procedures were thoroughly explained to the participants, and consent forms were distributed and signed. A specialist performed the preoperative evaluations and tests at an anaesthesiology clinic. In a supine position, patients underwent general anaesthesia via oro-tracheal intubation and then were repositioned to a prone position.

Based on a computer-generated randomization list, the corresponding surgeon was to select the type of surgery to perform. The same surgeon operated on all 84 patients and performed complete excision of the pilonidal tissues during the first phase of the operation. The second phase of the operation was determined by the patient's wound management group: Group 1 for the Z-plasty surgical technique (Fig. 1) and Group 2 for the secondary wound healing mechanism.

#### **Z-plasty surgical technique**

After initially marking the incision site with a marking pen, (Picture 1), the surgeon made a vertical elliptical incision that would encompass all of the pilonidal sinuses and tissues deep in the coccygeal bone. With the sinus tract as the centre, the vertical limb of the Z-plasty was thus formed. Two horizontal limbs were then drawn at a 60-degree angle in the direction of the main incision (Picture 2). After redirection of the flaps and insertion of a drain, the Z-plasty was repaired in multiple layers by the usage of PDS zero sutures (Picture 3). Simple nylon sutures were used to close the skin opening. After a dressing was applied, the patient was transferred to the recovery room.

#### **Secondary wound healing mechanism**

After full haemostasis, the wound was left open for secondary healing. For the dressing and the prevention of haemorrhage during the first hours of the early postoperative phase, wet gauze was placed inside the wound, and a dressing was applied on top.

Regardless of the trial group, the patient was then transferred to the surgery ward and admitted for a one-night stay for optimum pain control. Both groups received the same analgesic (Amp Apotel, 1 gr IV). The next day, patients were discharged from the hospital and, a few days later, were referred to the surgical clinic. The dressing method differed between the two groups. For Z-plasty patients, the dressing was left on for two days and then changed (3–5 times on average) until the wound was dry and free of secretions. The dressing was normally removed 5–7 days after the operation. In the secondary wound healing group, the dressing had to be changed once or more times a day, depending on the amount of wound secretions, until complete wound healing was achieved. Wound healing in the Z-plasty group occurred after suture removal. However, the secondary wound healing



**Picture 1.** Initial marking of the flap for Z-plasty repair technique.

group achieved healing after granulation tissue filled the cavity, and the epithelium completely covered it.

After discharge from the hospital, all patients were enrolled in a regular follow-up program. Both groups were visited regularly by a surgeon until the wound healed. A healed wound was defined as a dry scar that needed no further attention. In the Z-plasty group, the repair was completed after the removal of the stitches, after which patients were monitored over a period of six months for recurrence. In the secondary wound healing group, the dressing was changed daily by a nurse, and the patient was visited in an outpatient surgery clinic every two weeks by a surgeon and after 2 weeks, the sutures were removed. After wound healing, all patients underwent a 6-month screening for recurrence. Measured outcomes consisted of the patient's demographics (Table 1) Data [age, sex, and BMI], length of operation, complications, recurrence rate, wound healing time, Visual Analogue Scale (VAS) scores for two periods of time (the first 24 h after the



**Picture 2.** Redirection of flap limbs.



**Picture 3.** Final placements of flap limbs after repair.

operation and from the first postoperative day until the completion of wound healing).

SPSS version 22 performed the analyses, and quantitative data were expressed as mean/standard deviation and qualitative data as percentages and numbers.

According to the normal distribution of the data based on the Kolmogorov–Smirnov test, the independent *t*-test was used to compare the quantitative data, and the  $\chi^2$  test was used for the qualitative data. A *P* value less than 0.05 was considered statistically significant.

**Results**

In Table 1, the patient’s demographic data are presented. The Z-plasty group consisted of 19 males and 23 females, with a median age of 21.28 years. The secondary wound healing group was composed of 20 males and 22 females, with a median age of 22.09. Age or gender distribution did not significantly differ between the two groups. The median BMI (kg/m<sup>2</sup>) was 26.09 in the Z-plasty group and 26.07 in the secondary wound healing

**Table 1**  
Patients’ demographic data

	Z-plasty (n=42)	Secondary healing (n=42)	P
Age (years, mean ± SD)	4.27 ± 21.28	4.17 ± 22.09	0.38
BMI (kg/m <sup>2</sup> , mean ± SD)	2.26 ± 26.09	2.39 ± 26.07	0.96
Sex (cases)			
F	23 (54.8%)	22 (52.4%)	0.9
M	19 (45.2%)	20 (47.6%)	

F, female; M, male.

**Table 2**  
Surgical and postoperative data (mean ± SD)

	Z-plasty (n=42)	Secondary healing (n=42)	P
Operation time (min)	7.89 ± 52.97	7.11 ± 34.88	0.001 > <sup>a</sup>
Dressing number of	5.21 ± 4.95	23.56 ± 38.69	0.001 > <sup>a</sup>
Healing time (days)	4.27 ± 21.61	24.28 ± 41.23	0.001 > <sup>a</sup>
VAS score in first 24 h	1.13 ± 6.92	1.37 ± 6.97	0.86
VAS score after 24 h	0.76 ± 3.42	1.2 ± 6.09	0.001 > <sup>a</sup>

VAS, Visual Analogue Scale.

<sup>a</sup>Statistically significant.

group. With a *P* value of 0.96, the two groups had no significant difference.

As shown in Table 2 and Fig. 2, the length of the operation for Z-plasty subjects was significantly longer than that of the secondary wound healing group (*P* < 0.0001). The number of dressing changes needed for a complete course of wound healing was also measured. The median number of dressing changes for secondary wound healing patients was 38.69, significantly higher than the 4.95 dressing changes for the Z-plasty group. The total time recorded for complete wound healing was 21.61 ± 4.27 days in the Z-plasty group and 41.23 ± 24.28 days for secondary wound healing subjects, which was statistically significant.

The severity of pain experienced by patients in both groups was recorded twice by the VAS score (min:0, max:10). Twenty-four hours after surgery, the VAS score for Z-plasty patients was 6.92 ± 1.13 and 6.97 ± 1.37 for the secondary wound healing group. Thus, there was no significant difference between the two groups then. The second evaluation, however, showed that at 24 h postoperation, patients in the secondary wound healing group tended to feel more pain and that the VAS scores of the Z-plasty and secondary wound healing groups changed to 3.42 ± 0.76 and 6.09 ± 1.2, respectively.

As demonstrated in Table 3, the secondary wound healing group had a lower rate of wound infection than the Z-plasty group (4.8% vs. 7.1%); this was not a statistically significant difference (*P* = 0.9). Six patients (14.3%) in the secondary wound healing group and three Z-plasty patients (7.1%) experienced recurrence of the pilonidal sinus in the present study’s six-month follow-up. There were no significant differences between the two groups concerning the recurrence rate.

**Discussion**

Despite the various surgical and nonsurgical methods for treating pilonidal sinuses, no standard procedure has yet been proposed. The most appropriate treatment has long been a subject of debate. Although nonsurgical methods have gained popularity in recent years and, in some cases, have yielded acceptable results, the employment of different surgical techniques remains the mainstay of treatment in most surgical departments<sup>[19,20]</sup>. Most of these surgical techniques utilize a common approach consisting of complete excision of all sinus tracts and surrounding tissues until the sacro-coccygeal bone is reached. Until this stage of treatment, almost all surgical procedures use the same technique. After this stage, however, the differences in treatment methods become evident<sup>[21]</sup>.

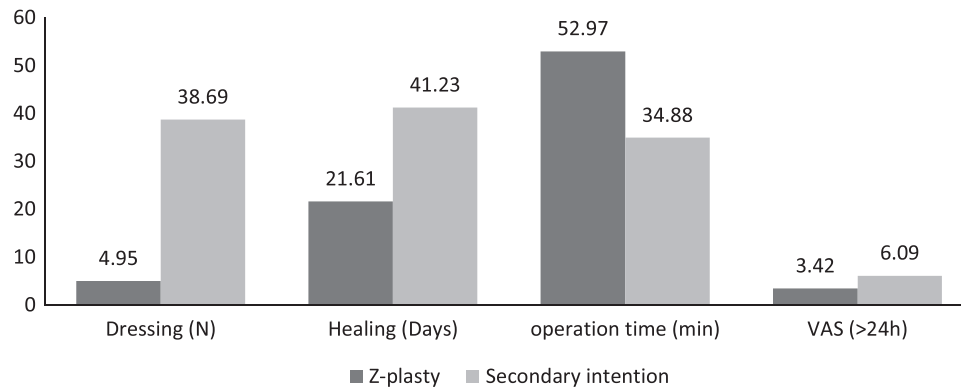


Figure 2. Surgical data. VAS, Visual Analogue Scale.

Traditionally, pilonidal sinus disease has been treated by excision of the sinus tract, leaving the wound open to heal by secondary intention. Due to the secondary wound healing method's higher monetary costs, longer duration of wound healing, pain, discomfort, and patient dissatisfaction, surgeons have considered using primary surgical wound closure techniques<sup>[1,21,22]</sup>. A wide variety of surgical techniques have been reported in the treatment of pilonidal sinuses. These techniques range from the simplest (initial closure with simple stitches) to complex methods of transferring surrounding tissue as flaps. These methods consist of off-midline techniques, such as an asymmetric or oblique incision as performed in the Karydakia-flap<sup>[4,5,23]</sup>, Limberg flap<sup>[24,25]</sup>, Dufourmentel, rhomboid flaps<sup>[26,27]</sup>, and other asymmetric procedures<sup>[28–30]</sup>. Full-thickness skin flap techniques, such as VY-plasty<sup>[31]</sup> or Z-plasty methods<sup>[14,32]</sup>, utilize full-thickness skin and subcutaneous tissue to cover the midline defect<sup>[1,22]</sup>. For pilonidal sinus treatment, the current research compares the results of two methods: secondary wound healing and the Z-plasty surgical technique.

**Operation time**

In the present study, the duration of surgery for the secondary wound healing group was significantly shorter than that of the Z-plasty group. The main reasons for the Z-plasty technique's lengthier operation are (1) two more incisions are needed, (2) homeostasis must be established to prevent haematoma under the flaps and (3) pressure on the suture line is not reduced by closure of the flaps in one layer, so the flaps must be repaired in several layers with absorbable PDS sutures (poly-dioxanone suture) to prevent suture line pressure. In the Z-plasty method, extreme care must be taken to minimize the chance of necrosis of the flaps, a disastrous outcome. In the current work, no cases of flap necrosis occurred. The methods employed to ensure a well-vascularized flap are as follows: (1) flaps made with the fewest number of cuts and as low as possible, (2) electrocautery used as

sparingly as possible, (3) no deep and bulky stitches in the flap part of the wound, and (4) flaps repaired in several layers without tension. The length of operation for the Z-plasty patients was significantly longer than that of the secondary wound healing group (traditional method). Even though the Z-plasty procedure is not very complex, it is technically more demanding. Dogra *et al.*<sup>[6]</sup> reported an average operating time of 75 min for Z-plasty, which is longer than the open method but similar to other primary closure techniques. A literature review reported an average time of 34.59 min for the traditional method<sup>[21]</sup>. In Praveen *et al.*<sup>[33]</sup>'s study, the operation length for Z-plasty ranged between 30 and 45 min, which is closer to the findings of the current study (52.97 ± 7.89 min). Yang *et al.*<sup>[34]</sup> reported that the operation length for Z-plasty was significantly longer than that for the simple excision technique since Z-plasty requires tissue release to create the flap and more suturing.

**Wound healing duration**

The duration of complete wound healing in the Z-plasty group was shorter than in the secondary wound healing group. In Z-plasty patients, the present study considered healing as when wound stitches were removed. However, for secondary wound healing patients, healing requires that the wound be filled with granulation tissue and then covered by epithelium that migrates from surrounding normal skin to completely cover and close the wound. From the patient's perspective, the most challenging part of pilonidal sinus disease is the recovery time. The traditional secondary wound healing method takes weeks to months to attain complete wound healing. The present study showed that the wound healing process was significantly shorter for Z-plasty patients, who were able to resume normal life activities sooner. In 2014, Priyadarshi and colleagues studied a total of 50 pilonidal sinus cases divided into two analogous groups. The mean hospital stay and total recovery time were reported to be significantly longer with the open method<sup>[15]</sup>. Sorate *et al.*<sup>[35]</sup> also reported that the total recovery time and hospital stay were longer for the open technique than for the Limberg flap or Z-plasty methods. In Yang and colleagues' study, the hospital stay was significantly shorter for patients in the Z-plasty group. Although the complete recovery time was not measured, it was concluded that Z-plasty patients needed less time for total recovery than patients who underwent a simple excision<sup>[34]</sup>. Anandaravi and colleagues compared two techniques in pilonidal sinus treatment: primary

**Table 3**  
Postoperative complications and recurrence

	Z-plasty, n (%)	Secondary healing, n (%)	P
Infection	3 (7.1)	2 (4.8)	0.9
Recurrence	3 (7.1)	6 (14.3)	0.48

closure and laying open. The Limberg flap, Karydakis technique, and Z-plasty surgeries were studied for primary closure. A shorter duration for wound healing and an earlier return to work were statistically significant in the primary closure group<sup>[36]</sup>. Fazeli *et al.*<sup>[3]</sup> reported the same results.

### **Pain**

Although the observed pain levels aligned with typical expectations for pilonidal sinus surgeries in both groups; Compared to the Z-plasty group, the severity of pain for patients in the secondary wound healing group was clearly greater and harder to bear ( $P < 0.0001$ ).

One of the hypotheses explaining the lower amount of pain in Z-plasty patients is the lower amount of tension on the repaired tissues, which lessens tissue stimulation and, thus pain. In the study of Priyadarshi *et al.*<sup>[15]</sup>, the VAS was significantly higher (more pain) in the open technique group than in the Z-plasty group. Arvind and colleagues showed a significant improvement in pain severity after Z-plasty repair. The mean VAS score for coccygeal pain decreased from  $7.33 \pm 0.5$  to  $2.11 \pm 1.2$  ( $P < 0.05$ )<sup>[37]</sup>. Elshazly reported significantly lower postoperative VAS scores in the Limberg group ( $2.1 \pm 1.2$  versus  $5.2 \pm 1.4$ ), presumably because of the lower wound tension in the Limberg flap procedure<sup>[38]</sup>.

Fazeli *et al.*<sup>[3]</sup>, on the other hand, found no significant difference in the severity of pain experienced by patients. Some studies do not support the findings that Z-plasty patients experience less severe pain. For example, Yang and colleagues reported that postsurgical pain by the VAS score was significantly higher in patients treated by Z-plasty than in those treated by simple excision. However, at the end of the third postsurgery week, there was no significant difference in pain between the two methods<sup>[34]</sup>.

### **Dressing**

The number of dressings applied in the Z-plasty group was significantly fewer than that in the secondary wound healing group. In Z-plasty, wound care after hospital discharge was performed by the patient at home. In contrast, patients in the secondary wound healing group required a healthcare professional for wound care after discharge. Therefore, although the care costs were not precisely calculated in his study, it is safe to believe that Z-plasty is more cost-effective than traditional secondary wound healing. Fazeli *et al.*<sup>[3]</sup> observed similar results and concluded that Z-plasty required significantly fewer dressing changes and posthospitalization health care, which suggested lower postoperative care costs despite lengthier hospitalization and longer operations. In Hameed's research showed that fewer dressing changes in the primary closure technique significantly lowered the total cost of treatment in comparison to the secondary wound healing group<sup>[39]</sup>. Rao *et al.*<sup>[32]</sup> reported that closed wounds required significantly fewer dressings than open wounds and remarkably lower costs.

### **Recurrence and complications**

As reported in the literature, the wound infection rate after off-midline closure techniques is  $\sim 6.3\%$ <sup>[2]</sup>. The current study observed a 7.1% wound infection rate among Z-plasty patients and a 4.8% rate among patients in the secondary wound healing group. The recurrence rate was 7.1% in the Z-plasty group and 14.3% in the secondary wound healing group. These results indicate no

significant difference between the two techniques regarding wound infection and recurrence rates, which are the two most critical factors when considering an ideal course of treatment.

There was no particular pattern regarding the contributing factors for complications since there were a small number of patients with postoperative complications. However, the few patients with recurrence and infection were those who got back to work too soon and had a sitting job, therefore put more tension on the wound (truck driver or student). The recurrence cases were referred to the surgery ward for reoperation, and the infection cases were managed conservatively with simple drainage and antibiotic therapy.

Similar observations have been made in the literature. In their seven-year study, Abdul Jamali and colleagues utilized Z-plasty primary repair to manage 55 patients suffering from pilonidal sinuses. Most patients (74.5%) recovered with no complications<sup>[10]</sup>. In 2015, Rao and colleagues treated 40 pilonidal sinus patients using the Z-plasty technique. No tissue necrosis or recurrence in a six-month follow-up period was observed<sup>[32]</sup>. Yang *et al.*<sup>[34]</sup> reported a 5.88% and a 6.06% infection rate in their Z-plasty and simple excision groups, respectively; this was not statistically significant. In its six-month follow-up period, this same study saw only one case of recurrence, which belonged to the simple excision group. A meta-analysis indicated that, compared to primary midline closure, secondary healing of a pilonidal sinus is associated with a 58% lower risk of recurrence, which is statistically significant. Like the present work, the meta-analysis study reported no significant difference in the recurrence rate of open healing and off-midline primary closure techniques, such as Z-plasty<sup>[2]</sup>. The 30-case study by Anandaravi reported two cases of infection in its off-midline primary closure group and one case in the open healing group, results that are close to the present work's findings. There was also no recurrence<sup>[36]</sup>. In Parveen *et al.*<sup>[33]</sup>'s research of 40 patients treated with a Z-plasty flap, 6 (15%) had a superficial wound infection that was treated conservatively, and 5% experienced a recurrence reported four months after surgery. In Priyadarshi and colleagues' work, recurrence was found in 5.88% of the open technique group and none in the Z-plasty group. For wound infection, the difference between the two study groups in early postoperative complications was not statistically significant<sup>[15]</sup>.

Fazeli *et al.*<sup>[3]</sup> reported an infection rate of 13.9% in open-wound patients and 9.7% in the Z-plasty group, along with a recurrence rate of 4.2% in both groups. In Rao and colleagues' study of 40 patients treated with the Z-plasty method, there were no recurrences in the 6–12-month follow-up. Regarding postoperative complications, 5% of patients experienced numbness over the flap, 7.5% suffered from wound infection, and 12.5% developed wound seroma. Necrosis of the flaps did not occur<sup>[32]</sup>. Of the 20 patients treated by Z-plasty flaps in Dogra and colleagues' study, only two were diagnosed postoperatively with wound infection. No recurrence was reported in the 12–24-month follow-up period<sup>[6]</sup>.

The limitations of the present study are as follows: (1) the number of patients was limited, (2) all patients were treated in one centre, while it was better to have used several centres, and (3) the duration of the follow-up period (6 months) was not sufficient and should have been at least 2 years. This was due to uncooperative patients and limited resources, which may have affected the recurrence rate.

## Conclusion

The use of the Z-plasty surgical technique in the treatment of pilonidal sinuses is not only an inexpensive and easy procedure but also significantly reduces the time of wound healing, the severity of pain, and the number of dressings performed. Based on the results of this study, this method can be considered a suitable alternative for pilonidal sinus repair.

## Ethical approval

It is approved by the Ethics Committee of Birjand University of Medical Sciences, Iran (Ir.bums.REC.1395.256).

## Consent

Written informed consent was obtained from the patient for publication and any accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal on request. Written informed consent was obtained from the patient's parents/legal guardian for publication and any accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal on request.

## Source of funding

Birjand University of medical sciences.

## Author contribution

S.A.V.: study design, data collection, data analysis, data interpretation. H.A.D.: literature search, data collection. F.A.: literature search, writing. Z.A.: literature search, writing.

## Conflicts of interest disclosure

The authors declare no conflicts of interest. This investigation does not have any financial or personal relationships with other people or organizations that could inappropriately influence (bias) this work.

## Research registration unique identifying number (UIN)

The trial is registered in the Iranian Registry of Clinical Trials (IRCT id: IRCT20111211008375N16).

## Guarantor

Amirian Z.

## Availability of data and materials

The datasets generated and analyzed during the current study are not publicly available due to considerations of medical ethics but are available from the corresponding author on reasonable request.

## Provenance and peer review

This investigation was not invited.

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