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

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Abstract

Background

The most important step in the treatment of a pilonidal sinus is eradication by surgical excision. Over the years, a wide variety of 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 86 uncomplicated pilonidal sinus patients who were to undergo complete surgical excision of the pilonidal sinus. For wound healing, the 86 subjects were equally divided into two groups of 43 patients each. One group was selected for Z-plasty surgical wound closure and the other for the secondary healing mechanism. Outcomes measured for both groups consisted of demographic data, length of operation, complications, severity of pain, number of dressings, recurrence, and complete healing time.

Result

In both groups, there were no significant differences observed in demographic data (age, sex, and BMI). The number of dressings applied in the Z-plasty group was significantly fewer than that in the secondary wound healing group. The duration for complete wound healing among the Z-plasty subjects was statistically significantly shorter in comparison with the other study group. The length of operation for secondary wound healing patients was significantly shorter than that for the Z-plasty group. During the first 24 hours after surgical excision of the pilonidal sinus, the severity of pain, measured by the VAS (Visual Analogs Scale), was the same for the two groups. However, after the first 24-hour postoperative period, the severity of pain was significantly less for Z-plasty patients than for the secondary wound healing group (based on lower use of analgesics and higher satisfaction).

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, since its shorter healing time, easier wound care, and lower degree of pain facilitate a faster return to work. Therefore, Z-plasty can be considered an alternative to traditional treatment methods.

Trial registration:
The trial is registered in the Iranian Registry of Clinical Trials (IRCT id: IRCT20111211008375N16) in 01/06/2018.

1 Background

In recent years, treatment for pilonidal sinuses has undergone many changes and has moved toward nonsurgical methods. However, in most surgical centers, surgery remains the major approach to patient treatment or at least to 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.\(^1\)

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.\(^1\) Secondary wound healing is the oldest and most commonly used method among most surgeons because it is easily applied, requires no particular technique and is believed to have the lowest recurrence rate when compared to other methods.\(^2\) 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.\(^1,3\) 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 Karydakis flap\(^4,5\) 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.\(^1\) Z-plasty is a surgical technique for 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.\(^6\) Possible complications consist of tissue necrosis, early wound healing failure, infection, wound dehiscence, paresthesia over the flap, seroma or hematoma formation.\(^3,6,7\) Since the introduction of this method, many studies have investigated the efficacy and safety of Z-plasty. Most results have been in favor of this technique.\(^3,6,8^{–16}\)

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.
2 MATERIALS AND METHODS

The current research is a randomized clinical trial [balance block randomization (1:1) in parallel groups] and was conducted in Birjand, Iran, in the general surgery ward of Imam Reza Hospital, with which Birjand University of Medical Sciences is affiliated. The trial is registered in the Iranian Registry of Clinical Trials (IRCT id: IRCT20111211008375N16). Eighty-six patients were selected (Figure. 1) teenagers and adults (ages 16–33 years) suffering from an uncomplicated pilonidal sinus, the diagnosis of which was based on patient history and physical examination.

After surgical excision, the 86 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 (Body Mass Index) < 30, 3- no history of conditions that interfere with wound healing, such as diabetes, smoking, cancer, chemoradiotherapy, or corticosteroid, and 4- age between 15–35 years. The exclusion criteria included 1- 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 86, and these were divided into two groups of 43. 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 anesthesiology clinic. In a supine position, patients underwent general anesthesia via oro-tracheal intubation and then were repositioned to a prone position.

Based on a computer-generated randomization list, the corresponding surgeon was free to choose the type of surgery to perform. The same surgeon operated on all 86 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.

2.1- 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 center, 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.

2.2- Secondary wound healing mechanism

After full hemostasis, the wound was left open for secondary healing. For the dressing and the prevention of hemorrhage 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. 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, in the secondary wound healing group, healing was achieved 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. In the Z-plasty group, the repair was completed after 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 every two weeks by a surgeon. After wound healing, all patients underwent a six-month screening for recurrence. Measured outcomes consisted of the patient’s demographics (Table 1) Data [(age, gender, and body mass index (BMI)], length of operation, complications, recurrence rate, wound healing time, VAS scores for two periods of time (the first 24 hours after the operation and from the first postoperative day until the completion of wound healing).

3 RESULTS

In Table 1, the patients’ 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/m²) was 26.09 in the Z-plasty group and 26.07 in the secondary wound healing group. With a P value of 0.96, there was no significant difference between the two groups.
As shown in Table 2 and Figure 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, 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±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. 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 at that time. The second evaluation, however, showed that at 24 hours 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 $3.42 \pm 0.76$ and $6.09 \pm 1.2$, 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 ($P = 1$). 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. Concerning the recurrence rate, there were no significant differences between the two groups.

<table>
<thead>
<tr>
<th></th>
<th>Z-plasty</th>
<th>Secondary healing</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infection</td>
<td>$(7.1%)$</td>
<td>$(4.8%)$</td>
<td>1</td>
</tr>
<tr>
<td>Recurrence</td>
<td>$(7.1%)$</td>
<td>$(14.3%)$</td>
<td>0.48</td>
</tr>
</tbody>
</table>

### 4 DISCUSSION

Despite the various surgical and nonsurgical methods for the treatment of 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. ($^{17,18}$) Most of these surgical techniques utilize a common approach consisting of complete excision of all sinus tracts and surrounding tissues until the sacro-cocygeal 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. ($^2$)

Traditionally, pilonidal sinus disease has been treated by excision of the sinus tract and 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 ($^1,19,20$). 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 Karydakis-flap ($^{4,5,21}$), Limberg flap ($^{22,23}$), Dufourmentel, rhomboid flaps ($^{24,25}$), and other asymmetric procedures ($^{26–28}$). Full-thickness skin flap techniques, such as VY-plasty ($^{29}$) or Z-plasty methods ($^{14,30}$), utilize full-thickness skin and subcutaneous tissue to cover the midline defect ($^1,20$). For pilonidal sinus treatment, the current research compares the results of two methods: secondary wound healing and the Z-plasty surgical technique.
4.1- 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 hematoma 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. Shavinder Dogra et al. reported an average operating time of 75 minutes for Z-plasty, which is longer than the open method but similar to other primary closure techniques. (6) A review of the literature reported an average time of 34.59 minutes for the traditional method. (20) In Sughr Praveen et al.'s study, the operation length for Z-plasty ranged between 30–45 minutes, which is closer to the findings of the current study (52.97 ± 7.89 mins). (31) Yong-Ping Yang et al. 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. (32)

4.2- Wound healing duration

The duration of complete wound healing in the Z-plasty group was shorter than that in the secondary wound healing group. In Z-plasty patients, the present study considered healing as the time 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. In the traditional secondary wound healing method, it 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, S. Priyadarshi et al. 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. (15) Yamini Sorate et al. 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. (33) In Yong-Ping Yang et al.’s 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. (32) B.N. Anandaravi et al. compared two techniques in pilonidal sinus treatment: primary closure and laying open. For primary
closure, the Limberg flap, Karydakis technique, and Z-plasty surgeries were studied. A shorter duration for
wound healing and an earlier return to work were statistically significant in the primary closure group. (34)
Fazeli et al. reported the same results. (3)

4.3- Pain

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., the VAS was significantly higher (more pain)
in the open technique group than in the Z-plasty group. (15) Arvind et al. showed a significant
improvement in pain severity after Z-plasty repair. The mean VAS score for coccygeal pain decreased
from 7.33 ± 0.5 to 2.11 ± 1.2 (P < 0.05). (35) Elshazly reported significantly lower postoperative VAS scores
in the Limberg group (2.1 ± 1.2 versus 5.2 ± 1.4), presumably because of the lower wound tension in the
Limberg flap procedure. (36)

Fazeli et al., on the other hand, found no significant difference in the severity of pain experienced by
patients. (3) Some studies do not support the findings that Z-plasty patients experience less severe pain.
For example, Yong-Ping Yang et al. 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. (32)

4.4- 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 health care professional for
wound care after discharge. Therefore, Z-plasty appears to be more cost effective than traditional
secondary wound healing. Fazeli et al. 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. (3) In K.K. 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. (37) M. Rao et al. reported
that closed wounds required significantly fewer dressings than open wounds and remarkably lower costs.
(30)

4.5- Recurrence and complications

As reported in the literature, the wound infection rate after off-midline closure techniques is approximately
6.3%. (2) 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 in regard to wound infection and recurrence rates, which are the two most critical factors when considering an ideal course of treatment.

Similar observations have been made in the literature. In their seven-year study, Abdul Hakeem Jamali et al. utilized Z-plasty primary repair to manage 55 patients suffering from pilonidal sinuses. The majority of patients (74.5%) recovered with no complications. In 2015, Jagdeep Rao et al. treated 40 pilonidal sinus patients by performing the Z-plasty technique. No tissue necrosis or recurrence in a six-month follow-up period was observed. Yong-Ping Yang et al. 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. Similar to 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. The 30-case study by B. N. 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. In Sughra Parveen et al.'s research of 40 patients treated with a Z-plasty flap, six (15%) had a superficial wound infection that was treated conservatively, and 5% experienced a recurrence reported four months after surgery. In Siddhartha Priyadarshi et al.'s work, recurrence was found in 5.88% of the open technique group and none at all in the Z-plasty group. For wound infection, the difference between the two study groups in early postoperative complications was not statistically significant.

Fazeli et al. 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 Jagdeep Rao et al.'s study of 40 patients treated with the Z-plasty method, there were no recurrences in the 6- to 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. Of the 20 patients treated by Z-plasty flaps in Shavinder Dogra et al.'s study, only two were diagnosed postoperatively with wound infection. No recurrence was reported in the 12- to 24-month follow-up period.

The limitations of the present study are as follows: 1- the number of patients was limited, 2- all patients were treated in one center, while it was better to have used several centers, and 3- the duration of the follow-up period (6 months) was not sufficient and should have been at least two years.

**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, 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 by a secondary wound healing mechanism.

**List Of Abbreviations**

BMI  
Body Mass Index  
VAS  
Visual Analog Scale

**Declarations**

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**CONFLICT OF INTEREST**

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.

**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.

**Ethics approval and consent to participate**

Informed consent was waived by the Ethics Committee of Birjand University of Medical Sciences, Iran, in the general surgery ward of Imam Reza Hospital and was directed in accordance with the 1964 Helsinki Declaration and its future revisions. The trial is registered in the Iranian Registry of Clinical Trials (IRCT id: IRCT20111211008375N16). This study was approved by the Ethics Committee of Birjand University of Medical Sciences, Iran.

**Consent for publication**

Not applicable.
Author Contribution

Vejdan SA: study design, data collection, data analysis, data interpretation

Danesh HA: literature search, data collection

Amirian F: literature search, writing

Amirian Z: literature search, writing

References


**Pictures**

Pictures 1 to 3 are available in the Supplementary Files section

**Figures**
Figure 1

Flowchart of patients in this study
Figure 2

Surgical data

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- Picture1.png
- Picture2.png
- Picture3.png