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ORIGINAL ARTICLES

Lacing Dermatotraction Suturing Technique - An Inexpensive Alternative for Early Closure of Infected Surgical Wounds

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Abstract

Introduction: Hailing from a tertiary government-aided center, infected surgical wounds varying from diabetic foot and necrotizing fasciitis to surgical site infection are by far the most common cluster of cases encountered in our practice. Due to an overall lack of patient education on wounds, most of these patients present late, necessitating extensive debridement and tissue loss.

Aim and Objective: To describe the lacing dermatotraction technique and to study its application in aiding early secondary closure of infected surgical wounds.

Material and Methods: An interventional Study was conducted at VICTORIA Hospital, Bangalore, from February 2020 to October 2021. Fifty-four patients with Infected wounds were debrided until healthy margins were obtained, followed by applying the shoe-lace tension lacing suture. This consisted of an infant feeding tube running under loops of prolene fixed 1 cm away from the edge of the wound. One end of the IFT is anchored to the skin, and the other is held in position with single throws of no-1 silk suture, which can be loosened at the next sitting for adequate wound exposure, which aids in better debridement. The tension suture is again tightened to attain the maximal possible wound approximation. Thus, constant traction on the skin edges creates progressive closure until secondary closure is achieved.

Results: 54 Patients were enrolled**,** consisting of 8 amputation stump infections, 11 diabetic foot, 14 disarticulations, five bed sore, 12 fasciotomies, three mastectomy flap necrosis, and one traumatic avulsion. There were 38 males and 16 females, with a mean age of 53.4 years. The mean duration of the wound at presentation was 17 days, and they were subjected to an average of 11 days of debridement. Mean wound dimensions - length= 11.02cm, breadth=4.86cm and area = 53.55 cm2. On applying the lacing, the wounds were debrided for an average of 8.85 days with 2.9 tightening. Secondary closure was achieved in 45 (83.33%) patients.

Conclusion: The lacing technique is inexpensive and safe to achieve early secondary closure of infected wounds. It avoids the need for skin grafts, reducing the need for anesthesia, hospital expenditure, and duration of hospital stay of patients.

Keywords: Dermatotraction, Lacing, Wound, Secondary Closure

Introduction

Hailing from a tertiary government-aided center, infected surgical wounds varying from diabetic foot and necrotizing fasciitis to surgical site infection are by far the most common cluster of cases encountered in our practice. Due to an overall lack of patient education on wounds, most of these patients present late, necessitating extensive debridement and tissue loss. Additionally, most of these patients have multiple associated comorbidities. Hence, effective and early cures still need to be improved. [1].

The general guidelines followed in our institution for such cases is to expose the patient to serial surgical debridement under adequate antibiotic coverage based on the culture and sensitivity, along with the treatment of additional comorbidities and nutritional improvement, until the wound granulates.

On granulation, a reconstructive procedure, either a skin graft or flaps, is used to aid epithelization. Subjecting

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the patient to a second operative procedure adds to the morbidity, length of hospital stay, and cost and exposure to anesthetic medications. As most of these patients are long-term diabetics, added cardiovascular comorbidities are inevitable. Hence, most of these procedures are carried out at high risk.

We, therefore, describe a dermatotraction technique, where the wound's debrided margins are put under tension using a shoelace suturing, which can be loosened at the following setting, allowing further wound debridement. Following debridement, the lacing is retightened to keep the edges under stress. Skin is a viscoelastic organ with mechanical creep property, defined as the elongation of skin beyond its intrinsic extensibility over time due to a constant load.[3] Another application where this property of skin is used is tissue expansion for plastic reconstructive procedures.[4] Using these principles, we have innovated a technique to achieve early secondary closure of infected wounds, using readily available materials such as a pediatric catheter or IV drip set to apply traction on the wound edge to attain early secondary closure.

Materials and Methods

The study was designed as a prospective interventional study held between February 2020 and October 2021 in the Department of General Surgery at Victoria Hospital, affiliated with Bangalore Medical College and Research Institute. After obtaining ethical committee approval (BMCRI/PG/352/2019-20) and valid written informed consent, Patients with infected wounds having arterial Doppler within normal limits were included in the study. Circumferential injuries having an abnormal arterial doppler were excluded from the study**.**

To make the traction shoelace, we required the following

1. Hydrophilic pediatric catheter 8F to 12F
2. IV drip set
3. Prolene no one suture
4. Ethelon no 0, cutting suture
5. Mersilk no 1 cutting suture

Preparation of wound bed

The wound is debrided until a large portion of the slough is removed, and partial granulation tissue has been obtained. The edges are debrided until fresh, healthy margins are obtained. A completely sterile granulated floor is not a prerequisite for applying the shoelace, as the harness can be loosened at the following setting, and further debridement can be carried out. However, healthy margins are a prerequisite, as the anchoring sutures would cut through if applied on an unhealthy margin. Before using the tensioned suture, the wound's edges are freshened and undermined briefly to allow the anchoring suture to the healthy skin away from the indurated margin. The goal of the technique is to enable simultaneous wound approximation along with the proliferation of the floor.

Technique

In this technique, the pediatric catheter (no eight infant feeding tube - IFT) is fixed permanently to one end of the wound using proline, and no one sutures onto the normal skin. The catheter is then anchored to the opposite side of the wound using prolene, and no one sutures. The anchoring suture is applied from the skin's external surface to enter the wound and hook around the catheter, which is present underneath and then brought out externally. The anchoring suture is applied away from the indurated edge on the uninflamed skin. Additionally, the edge of the wound is kept free of tension to avoid ischemia and deter wound healing.

Similarly, the lacing is made to run along the wound while anchoring to the corresponding wound edges, similar to a shoelace, which, on contraction, allows the wound edges to approximate. The distal end of the lacing is anchored to the skin, one cm from the end of the wound, using temporary drain fix suturing by mersilk no. 1, where only single throws are used. The lacing can be loosened by untieing the drain, fixing the suture, and debriding the wound. Alternate day tightening is carried out until the approximation permits secondary closure.

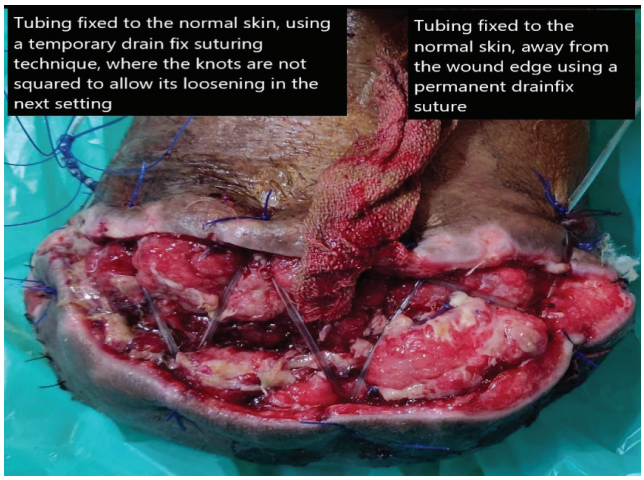

Figure 1 shows the shoelace application using a pediatric catheter of size 8F.

On retracting the tubing, the wound edges contract, and this traction is increased at each debridement setting until the edges can be closed with secondary suturing.

Variables concerning wound healing were expressed in terms of means with standard deviations. The variables calculated are the duration of debridement before application of the shoestring, the average number of debridements done before the supplication of the shoestring, the condition of the floor during application of the traction system- granulated or not, the dimension of the wound in terms of length, breadth, and area, number of days of debridement following the application of shoelace and number of tightening performed.

Results

Fifty-four patients were included in the study, consisting of 38 male patients (70%) and 16 female patients (29%). Many cases were included; the cases were initially debrided until healthy margins were obtained and the traction was applied.

The majority of cases were those of Diabetic foot. Eight patients had post-amputation stump infection (14.81%). 11 patients had diabetic-related infected wounds (20.37 %)

Fourteen patients had gaping wounds secondary to Disarticulations of digits (25.92%). Five patients had Bed sores (9.25%), 12 patients had Fasciotomy following compartment syndrome (22.22%), and three patients had flap necrosis following modified radical mastectomy (5.55%).

One patient had a Traumatic avulsion of the right leg following a railway injury, which was also investigated by this technique.

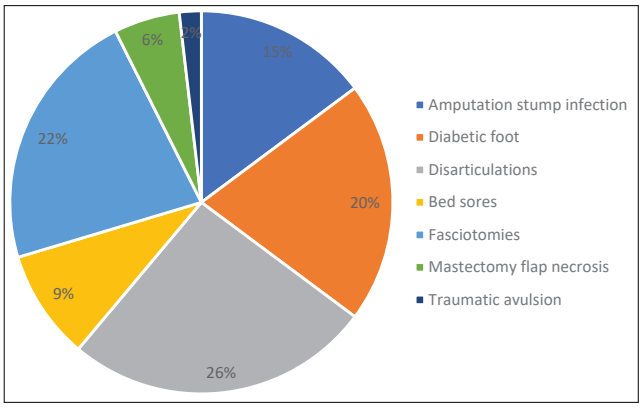

Figure 2: Depicting the various types of cases included in the study, along with their numbers

Mean debridement was 11.58 days before healthy margins were obtained, averaging 6.14 debridement. The debridement was carried out on an alternate-day basis. At the time of tubing application, healthy granulation tissue was present at the base in 38 out of 54 cases, but slough was present in 16 patients. The average length of the wound was 9 cm, and breadth was 4 cm, with a middle area of 44.13 cm^2.

After application of the traction, the wounds were simultaneously debrided and tightened for an average duration of 10.67 days, for a mean of 3.41 tightening.

The mean duration for wound healing was 22.25 days. The stretched skin was morphologically similar to the surrounding tissue except for mild hyperpigmentation noted around the region of stretched skin, which subsided in 6 weeks.

Secondary closure was achieved over most of the wound on day seven after the application of the traction. A small circular wound over the medial malleolus had to be grafted.

Out of the 54 cases, secondary closure was achieved in 45 patients (83.33%), while Secondary closure could not be completed in 9 patients. In cases where secondary suturing could not be reached, the size of the wound was significantly reduced—five of the nine patients healed without skin grafts, while four were treated with split-thickness grafts. The area of graft required was noticeably reduced. Out of the cases that could not be closed secondarily, most of the wounds involved the plantar aspect, owing to the less elastic nature of the sole. No other significant complications were noted.

However, we noticed significant wound contraction whenever secondary closure could not be achieved, which could be allowed to heal by secondary intention. In those who did required skin grafting, the size of the graft required was noticeably reduced. (figure 5)

The wound predominantly involved the sole of the left foot. The wound did not contract significantly during the successive tightening. The harness gave way on the 18th day post-application. Although secondary sutures could not be achieved, a significant reduction in wound breath was noted. The focus of the wound was shifted from the weight-bearing area of the foot to the medial aspect, which allowed the patient to carry out his daily routine.

SL No	PARAMETERS	MEAN VALUE	MEDIAN VALUE
1	*Duration Of Debridement before the Procedure*	**11.58 Days**	10 Days
2	*Number of Debridement before Application of Lacing*	6.14	6
3	*Condition of floor*	Slough Present = 16 Granulation Present = 38	
4	*Length of Wound*	9.33 Cm	9 Cm
5	*Breadth of Wound*	4.73 Cm	4 Cm
6	*Area of Wound*	44.13 Cm2	
7	*No. of Days of Debridement Following Shoelace*	10.67 Days	
8	*Number of Tightening*	3.41	Min = 1 Max = 7

Table 1: Depicting the mean duration of pre-procedure debridement and post-procedure debridement along with the mean dimensions of the wound studied.

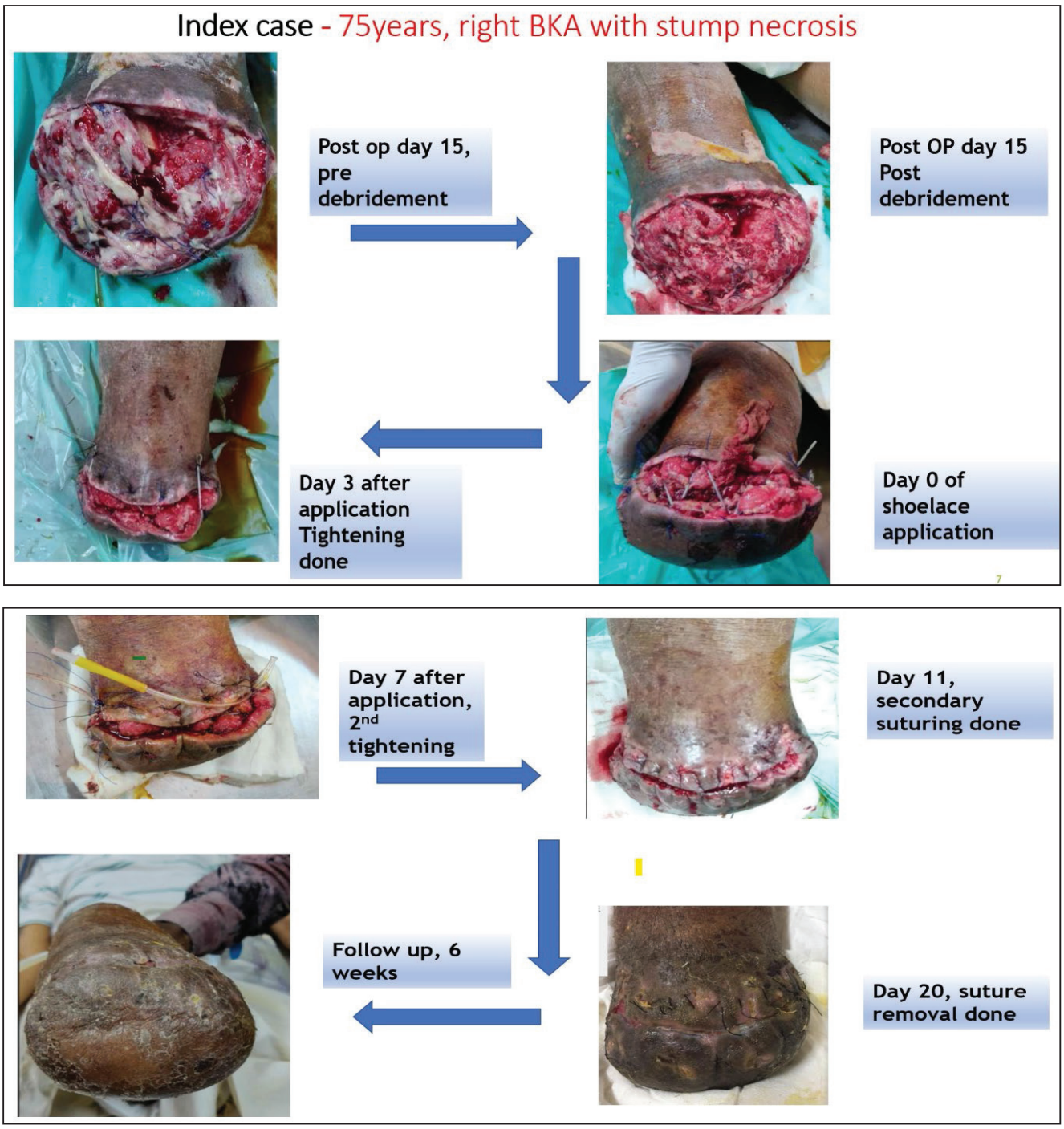

Figure 3: Case of right below knee amputation stump necrosis. The patient was debrided until healthy margins were achieved and the lacing was applied.

Discussion

The known accepted gold standard for closure of raw area is split skin grafting.[5] The dermatotraction technique substitutes split skin graft to close raw areas whenever feasible. It is especially advantageous when we are dealing with necrosed post-amputation flaps. In such cases, although the skin cover may be adequate, the proliferation and fibrosis in the granulating floor cause a relative retraction of the wound edge. This makes secondary suturing difficult. The dermatotraction technique addresses this issue by facilitating the approximation of the edges.

To our knowledge, this technique has been tried previously on fasciotomy wounds, especially in the setting of fracture wounds.[6] In this study, we have extended its application to various wounds involving various body parts.

A well-granulated ulcer floor and obtaining a sterile wound culture are paramount among the various prerequisites of skin grafting or flaps. A study conducted by *Unal S et al.*

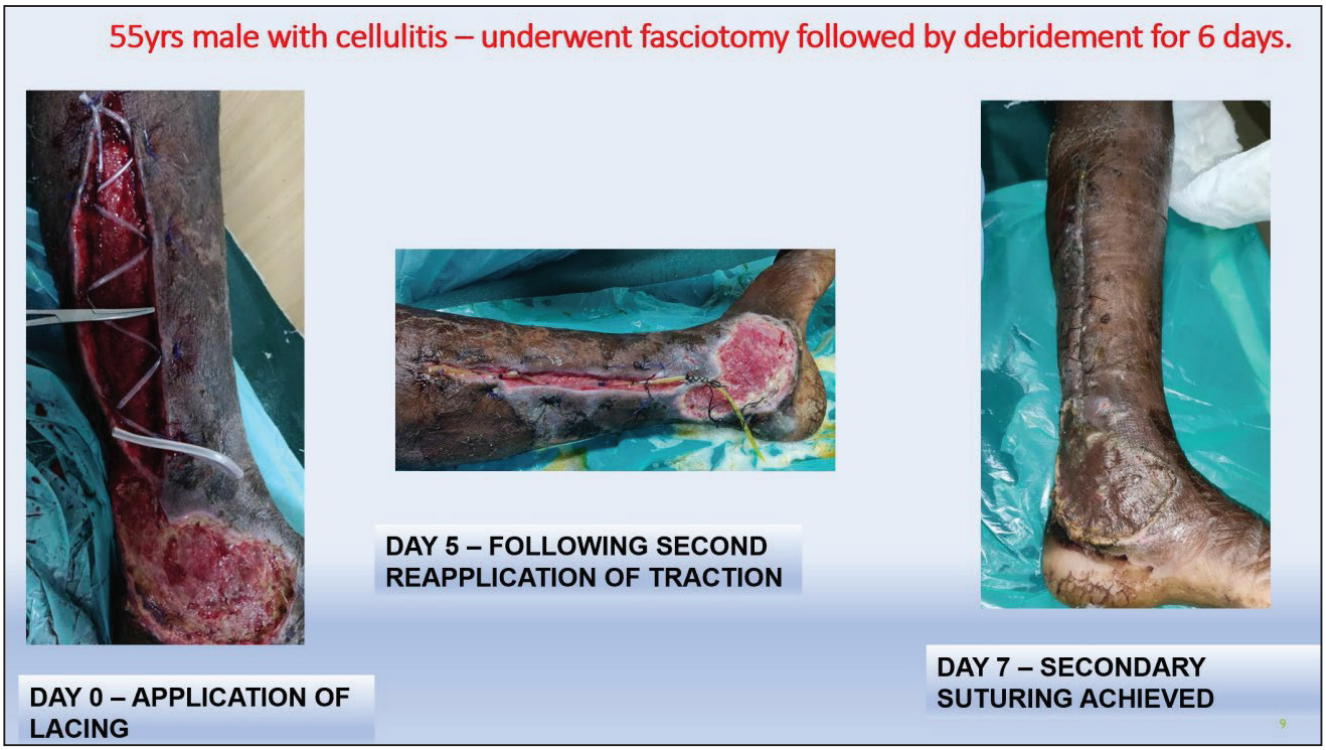

Figure 4: The Case Of Cellulitis Who Underwent Fasciotomy Was Treated With This Technique.

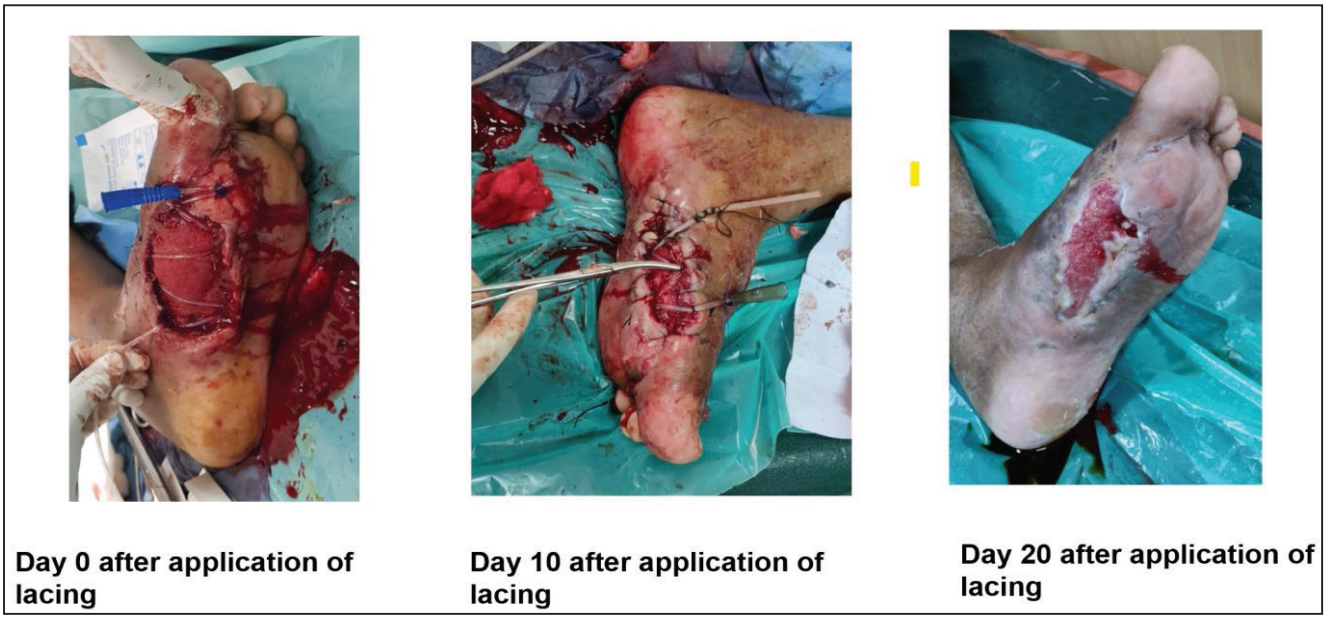

Figure 5: Case of a 27-year-old with type 1 diabetes with diabetic foot.

concluded that the microbiological cultures of the wound bed of failed grafts revealed Pseudomonas aeruginosa in 58.1% of the cases, followed by Staphylococcus aureus, Enterobacter, enterococci, and Acinetobacter. [7]

In our technique, we found that the traction can be applied while simultaneously debriding the wound. Therefore, strict culture negativity of the wound floor is not required before using the traction. As the wound is not entirely closed in the first setting, there is adequate space for the discharge and the pus to escape.

The other disadvantages of split skin grafts are its relative contraindication if the recipient site is over bones, joint capsule, and tendons, the need for anesthesia and fitness for surgery, and the risks involved with anesthesia. The procedure requires post-operative slab immobilization for variable periods. The Donor site dressing is to be applied for 21 days; donor site pain and scar and Graft rejection are the other disadvantages. The traction technique can overcome some of these issues. The traction can be applied to the skin over tendons and bones. However, we did not

investigate the efficacy of the joint surface in this study. The procedure is done under local anesthetic blocks and does not require fitness for surgery or exposure to general anesthesia or other invasive anesthetic agents. The requirement of the done site is overcome, thereby avoiding the creation of another wound and its associated complications. Slab immobilization was not necessary for this procedure.

The other main advantage is that the patient can be discharged after applying the traction and can be dressed on an outpatient basis. Comparing it to a study conducted by *John J. Anderson et al.* on Split-thickness skin grafts for the treatment of non-healing foot and leg ulcers in patients with diabetes, a retrospective review concluded that the time to complete wound healing ranged from 3 to 16 weeks, average time of 5.1 weeks.[8]

However, another study by *Ramanujam CL et al.* on Split-thickness skin grafts for closure of diabetic foot and ankle wounds: a retrospective review of 83 patients inferred that out of the 83 patients, 54 (65%) healed uneventfully, 23 (28%) suffered graft rejection, requiring regrafting.[9]

The technique under discussion utilizes the property of mechanical creep to achieve secondary closure**.** This property was studied by Muhammad *Abdur Razzak et al.* on a cellular and microscopic level; the study revealed that there was Increased density and thickness of the epidermis by up to 40%, along with a Remarkable increase in the mitotic activity of the epidermis. The stretched tissue Maintained the phenotypical characteristic of the parent epidermis. There was Increased collagen synthesis in the dermis during tissue expansion and Temporary hyperpigmentation in expanded tissue upon up-regulation of melanin expression during tissue expansion. This temporary hyperpigmentation was consistent with our findings.[10]

The study, however, has several limitations. This technique was previously applied to only fasciotomy wounds in the published literature; our experience is limited concerning the case selection and the dimension of the wounds where the yield for secondary closure would be higher. We also found that skin over certain areas does not stretch sufficiently for secondary closure. One such location is the sole and is over the malleolus.

The wounds' etiology and presence in multiple body parts provide a heterogeneous cohort, making comparisons difficult. More concrete evidence in extensive studies involving wounds over multiple body surfaces is required. Additionally, randomized control studies comparing this technique with skin grafting would clear more doubts about its advantages.

Conclusion

With the initial evidence, the lacing technique seems inexpensive and safe to achieve early secondary closure of post-debridement wounds. It avoids the need for free skin grafts, reducing anesthesia and hospital expenditure. Case selection is an essential aspect of preventing compartment syndrome and vascular compromise. We also do not recommend the application of traction over the sole of the foot.

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Competing interests - nil
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Authors' contributions - primary investigator devised the lacing technique, performed the procedures on patients, followed up with patients, collected data, and wrote articles.
Acknowledgments - nil

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