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Split-thickness skin grafting the high-risk diabetic foot

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Objective: **The application of split-thickness skin grafts (STSGs) to chronic extremity wounds has often been considered undesirable because of the perceived high incidence of failure, especially in neuropathic patients with plantar diabetic foot wounds. The purpose of this study was to evaluate the outcomes of STSG placement in patients with chronic lower extremity wounds.**

Methods: **We abstracted data from consecutive patients at our institution from January 2007 through April 2013 who underwent STSG placement by vascular and podiatric surgeons for chronic wounds of the lower limb and foot. Patients were monitored for at least 24 weeks, unless the wounds healed sooner.**

Results: **There were 94 patients (72% male) in the study group, with a mean age of 61.0 ± 12.8 years. Of these, 66 patients had diabetes, including 13 who were dialysis-dependent; the remaining 28 had other chronic nondiabetic wounds. The average duration of follow-up was 12.0 ± 12.9 months. After STSG placement, 65 (69.1%) experienced complete graft incorporation and healing, and 18 (19.1%) required revision, five (5.3%) of whom ultimately required major limb amputation. There were no differences in healing when wounds in patients with and without diabetes or plantar vs nonplantar wound locations were compared ($P > .05$). Similar results were observed after adjusting the results for initial wound size. Although dialysis patients had a threefold higher rate of STSG revision (46.2% vs 14.8%; $P = .01$), the cumulative rate of wound healing as a function of time was independent of end-stage renal disease ($P = .83$).**

Conclusions: **The results of this study suggest that STSG may be an effective method for promotion of wound healing in the management of chronic lower extremity wounds irrespective of wound location and presence of diabetes. (J Vasc Surg 2014;59:1657-63.)**

Worldwide, 371 million people are currently living with diabetes, a number that continues to rise. In 2012 alone, $481 billion were spent to take care of these patients.[1] Considering the massive effect of this disease, we must be fully equipped to take care of all of the associated comorbidities. As a result of associated neuropathy and peripheral vascular disease, this patient population has a significant risk of lower extremity ulceration, especially on the weight-bearing surface of the foot. Annually, ulceration occurs in 2% to 3% of such patients[2] and at least once in 25% of people with diabetes during their lifetime, with half becoming infected. Once infected, one in five ulcers leads to amputation.[2-4] The treatment of diabetic ulcers is costly. The average estimated cost of treating an ulcer in the United States in 1999 was $28,000.[2]

Many techniques exist to heal chronic wounds, most of which focus on secondary intention. Split-thickness skin graft (STSG) placement has rarely been discussed as a primary means of healing wounds, particularly those on the diabetic foot. A recent study by Ramanujam et al[5] compared STSG placement in people with and without diabetes, thus supporting previous work at their single center, but they did not specifically discuss wound chronicity or location. We are unaware of any reports in the literature that have evaluated outcomes—and compared plantar wounds with other anatomic locations—in a series of primarily diabetic chronic wound patients undergoing STSG placement.

METHODS

We retrospectively analyzed the inpatient and outpatient records of all consecutive patients at our institution from January 2007 through April 2013 who underwent STSG placement performed by vascular and podiatric surgeons as part of an integrated surgical limb salvage service. All affected patients had chronic lower extremity wounds. Patients who had undergone a fasciotomy or whose wounds were associated with antecedent trauma were excluded from the study.

A total of 94 patients met inclusion criteria. We examined multiple factors in the study group, including patient age, sex, presence of diabetes, presence of dialysis-dependent renal failure, indication for STSG, wound location (plantar vs nonplantar), graft size, time to healing, and ambulatory status. If ambulatory status was not stated in the records, we presumed the patient remained ambulatory. Because preoperative hemoglobin A_{1c} levels were

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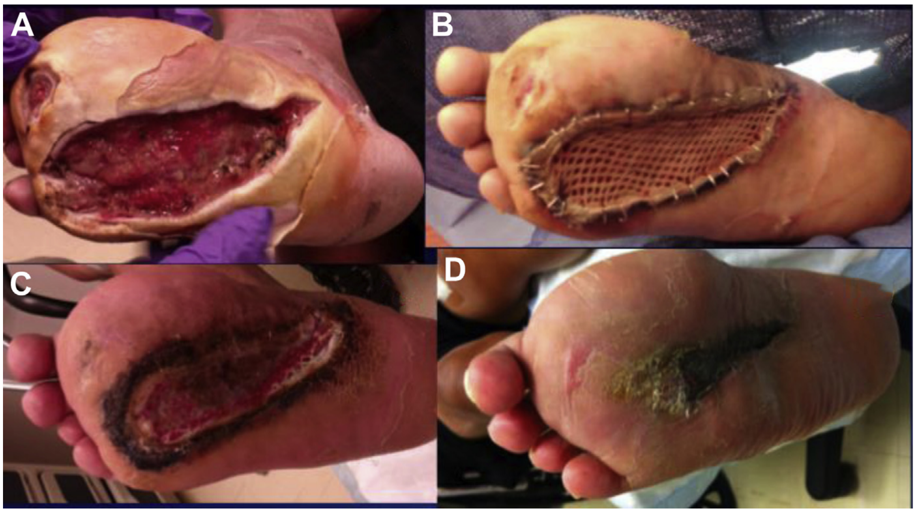

Fig 1. Example of plantar skin graft healing: wound is shown **(A)** before graft placement, **(B)** immediately after graft placement, at **(C)** 3 weeks after graft placement, and **(D)** at 8 weeks, the wound has healed.

inconsistently documented, mean levels were not calculated. Wound healing was defined as the presence of complete graft healing and incorporation without drainage.

STSG placement was performed in a consistent fashion. Patients required a healthy, granulation bed, which was usually aided by preoperative debridement and treatment with a wound vacuum-assisted closure device. In the operating room, wounds were sharply debrided to healthy, bleeding tissue, with a surgical blade or using hydrodebridement (Versajet; Smith & Nephew, London, UK).

Once the wound bed was adequately prepared, we harvested the graft (usually from the ipsilateral thigh). The area to be harvested was anesthetized with 1% lidocaine with epinephrine and then lubricated with mineral oil. An electric dermatome was used to harvest the skin at a range of 0.012 to 0.018 inches thick. The graft was then piecrusted or meshed at a ratio of 1.5:1 and placed onto the wound bed. The graft was sutured in place using 4-0 chromic gut sutures. Recipient sites were dressed with negative-pressure wound therapy (NPWT) for 3 days, followed by a compressive dressing and aggressive protection from external pressure. The donor site was dressed with occlusive petrolatum gauze with 3% bismuth tribromophenate, 4×4 gauze pad , and transparent film dressing (Tegaderm, St. Paul, Minn). Wounds were assessed weekly.

As part of the clinical protocol, all patients received location-specific offloading. For plantar wounds, this included 4 weeks of a removable cast walker (DH pressure relief walker; Ossur, Reykjavik, Iceland), followed by total contact casting, or instant total contact casting, as tolerated. Nonplantar wounds received edema-control and trauma-protection dressings. Fig 1 depicts a typical patient at various steps in the STSG placement process.

Data for continuous variables are reported as the mean ± standard deviation, and for non-normally distributed continuous variables, median values are reported. The Kolmogorov-Smirnov test was used for testing normal distribution of continuous variables. Between-group comparison was performed at 8 weeks and at the end of study (24 weeks or until healing). We used a χ^2 test to assess all dichotomous variables.

Data were grouped by presence of diabetes and plantar or nonplantar wound location. The univariate analysis of covariance or independent Mann-Whitney test, as appropriate, was used to compare the wound-healing times between groups. Patient age and sex were considered as covariates. In addition, results were weighted according to the initial wound size. Between-group differences for other variables, including gender, wound size, follow-up duration, number of healed ulcers, and number of required revisions, were examined using analysis of variance and the Fisher exact test or χ^2, as appropriate. Baseline wound size was also dichotomized to large wound size (cutoff of 80 cm^2),[6] and the Kaplan-Meier test was used to compare between-group differences for time to wound healing. The log-rank test was used to estimate differences in wound survival probability between groups, and the Cox regression model (forward conditional) was used to estimate survival difference between groups for time to healing, with patient age and wound size at baseline as covariates.

Finally, to identify independent predictors for failure of wound healing at the conclusion of the study, we used a logistic backward model. We considered failure as the dependent variable and used age, gender, presence of diabetes, location of wound (plantar or nonplantar), presence of end-stage renal disease (ESRD), and the presence of large wound size (wound size of $\geq$80.0 cm^2) as independent variables. A P value of $\leq$ .05 was considered statistically significant. Statistical analyses were performed using SPSS 21 software (IBM Corp, Armonk, NY).

RESULTS

The study group comprised 94 patients (72.4% male) who were a mean age of 61.0 ± 12.8 years (median,

Table I. Patient and wound characteristics for patients with and without diabetes

Variable[a]	*Patients without diabetes (n = 28)*	*Patients with diabetes (n = 66)*	P
Age, years	63.7 ± 13.5	59.8 ± 12.4	.18
Gender			
Male	20 (71.4)	45 (68.1)	.81
Female	8 (28.6)	21 (31.8)	
Location			.03
Plantar	14 (50.0)	49 (74.2)	
Nonplantar	14 (50.0)	17 (25.7)	
Wound size, cm^2	116.3 ± 216.2	66.3 ± 87.5	.13
Large wound size, >80 cm^2	8 (28.6)	13 (19.7)	.42
Follow-up duration, months	12.1 ± 12.6	12.0 ± 13.2	.96
Wound healing outcome			
Fully healed	21 (75.0)	44 (66.7)	.47
Required revision	3 (10.7)	15 (22.7)	.25
Still unhealed	6 (21.4)	18 (27.2)	.62
Required amputation	1 (3.6)	4 (6.0)	1
Time to successful wound healing, weeks	8.8 ± 6.5	7.2 ± 4.7	.31

[a]Continuous data are shown as the mean ± standard deviation and dichotomous data as number (%).

Table II. Patient and wound characteristics for plantar and nonplantar wounds

Variables[a]	*Patients without plantar wounds (n = 31)*	*Patients with plantar wounds (n = 63)*	P
Age, years	63.8 ± 11.75	59.6 ± 13.1	.13
Gender			
Male	19 (61.2)	46 (73.0)	.34
Female	12 (38.7)	17 (26.9)	
Presence of diabetes			.03
Diabetes	17 (54.8)	49 (77.8)	
No diabetes	14 (45.1)	14 (22.2)	
Wound size, cm^2	132.7 ± 216.0	50.5 ± 35.8	.009
Large wound size, > 80 cm^2	11 (35.4)	10 (15.8)	.03
Follow-up duration, months	8.5 ± 9.8	13.8 ± 14.0	.06
Wound healing outcome			
Fully healed	23 (74.1)	42 (66.7)	.49
Required revision	5 (16.1)	13 (20.6)	.25
Still unhealed	6 (19.3)	18 (28.6)	.45
Required amputation	2 (6.5)	3 (4.8)	1
Time to successful wound healing, weeks	8.1 ± 5.8	7.5 ± 5.1	.69

[a]Continuous data are shown as the mean ± standard deviation and dichotomous data as number (%).

62.0 years). Of these, 66 (70.2%) had diabetes, including 13 who were dialysis-dependent, and the remaining 28 had venous leg ulcers or other chronic nondiabetic wounds. The average duration of follow-up was 12.0 ± 12.9 months (median, 6.5 months; range, 0.5-52 months). The mean baseline wound size was 81.6 ± 140.3 cm^2 (median, 41 cm^2). The average duration of wound healing in the successful patients was 7.7 ± 5.4 weeks (median, 5.0 weeks). Patients and wound characteristics are summarized in Table I.

After STSG placement, 65 patients (69.1%) experienced complete wound healing. The 29 patients whose wounds did not heal were treated with a combination of local wound care and healing by secondary intention. At the end of the study, the wounds in 70 patients (74.5%) were successfully healed, and 19 (20.2%) failed to heal. Five patients (5.3%) required amputation. To further examine the effect of diabetes and wound location on outcomes of wound healing, participants were classified as diabetes vs no-diabetes (Table I) and as plantar wound vs nonplantar wound (Table II).

Patients with and without diabetes had a similar gender distribution (71.4% vs 68.1% male). The mean age was 63.7 ± 13.5 years in the overall study population and was similar, at 59.8 ± 12.4 years, for those in the diabetes subgroup ($P = .18$). Patient age and gender did not appear to significantly affect outcome ($P > .05$). No differences between groups were observed for the initial wound size, number of patients with large wound size (wound size of ≥80 cm^2), and the duration of follow-up (Table I). However, the proportion of plantar wounds was higher in the diabetic group (74.2%) compared with those without diabetes (50.0%; $P = .03$). When wounds were compared by presence of diabetes, no differences were observed for the number of fully healed patients, the requirement for revision, or ambulatory status. Of the 66 patients with diabetes, wounds in 44 (66.7%) healed primarily after STSG placement, without revision or without the requirement for secondary healing, compared with 21 (75.0%) of the nondiabetic patients. Similarly, wounds in 18 (27.2%) failed to heal in the diabetic group vs six (21.4%) in nondiabetic group (Table I). A similar proportion of diabetic wounds (50.0%) healed in 8 weeks compared with nondiabetic wounds (48.0%; $P = .44$).

The mean time to wound healing was 7.2 ± 4.7 weeks in patients with diabetes compared with 8.8 ± 6.5 weeks in those without diabetes. The difference of −1.6 weeks was not significant (95% confidence interval, −4.7 to 1.5 weeks; $P = .31$). Wounds that were >80 cm^2 at baseline were less likely to heal, with a 52% success rate in the group with a large wound vs 74% success rate in the group with a small-sized wound ($\chi^2 = 3.56$, $P = .05$). The mean wound size in patients without diabetes was 116.3 ± 216.2 cm^2, which was greater than the mean area of 66.3 ± 87.5 cm^2 in those with diabetes; however, the difference was not significant ($P = .13$). We observed no significant difference in wound-healing time between those with and without diabetes after we weighted the results by (and thus controlled for) initial wound size ($P = .7$). Fig 2 illustrates the patient survival curve by time to wound healing as a function of the presence or absence of diabetes. Results suggest no significant difference in time to healing by presence of diabetes with the numbers available for assessment ($\chi^2 = 0.315$, $P = .57$). Age and baseline wound size were also not significant predictors in our time-to-event model.

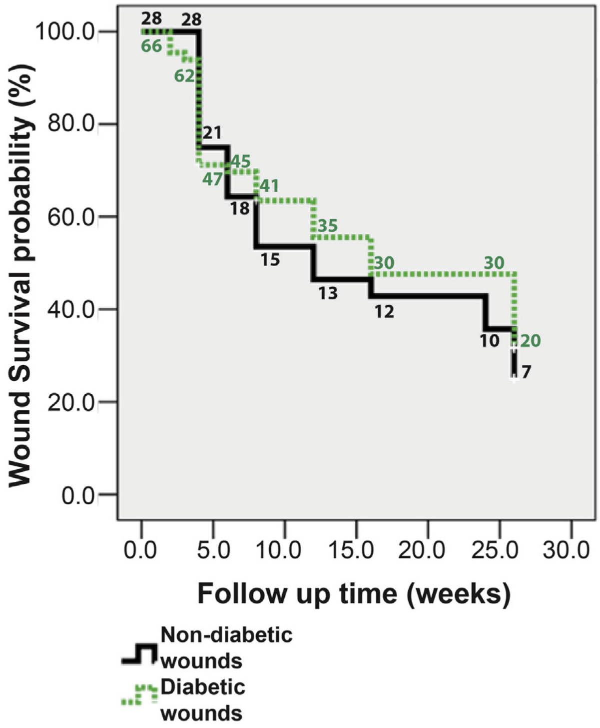

Fig 2. Wound-healing time is shown for diabetic wounds vs nondiabetic wounds.

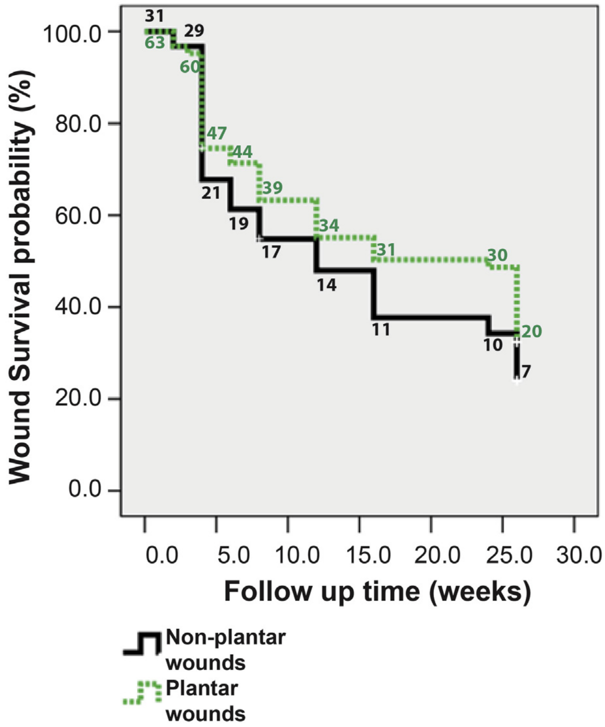

Fig 3. Wound healing time is shown for plantar vs nonplantar wounds.

When wound healing was compared by anatomic location, we did not detect a significant difference in wound healing between plantar and nonplantar wounds (7.5 ± 5.1 vs 8.1 ± 5.8 weeks; $P = .69$), −0.6 weeks (95% confidence interval, −3.63 to 2.4 weeks). Most plantar wounds were in the diabetic group (77.8%) compared with 22.2% in the nondiabetic group ($P = .03$). Wound size and number of patients with large wound size (≥80 cm^2) were higher in the nonplantar wound group compared with planar wound group ($P < .05$). Despite these observed differences, the outcomes of wound healing, including number of successfully healed, number requiring revision, and number of amputations, were the same between groups ($P > .05$; Table II). Fig 3 illustrates the patient survival curve by time to wound healing as a function of anatomic location. There was no significant difference in time to healing by wound location ($\chi^2 = 0.522$; $P = .47$). According to the Cox regression model, baseline wound size and patient age were not significant predictors of time to healing when we compared patients with and without diabetes. A similar proportion of plantar wounds healed in 8 weeks (57.1%) compared with nonplantar wounds (67.4%; $P = .44$).

We also evaluated the effect of ESRD on wound healing (Table III). Overall, the outcomes of wound healing were the same between patients with and without ESRD. However, ESRD patients had a threefold higher rate of revision of 46.2% vs 14.8% without ($P = .01$). Time-to-event analysis suggests that the cumulative survival for successful wound healing as a function of time is independent of ESRD status ($\chi^2 = 0.045$; $P = .83$).

Considering many of our patients have concomitant vascular disease, we also evaluated whether revascularization before STSG affected wound healing compared with patients who did not require revascularization based on physical examination and the results of noninvasive testing (Table IV). Thirty-seven patients had a revascularization procedure before undergoing STSG. Of those, 19 (51.4%) were performed by an endovascular approach, 16 (43.2%) were open surgical bypasses, and two (5.4%) had open and endovascular procedures. Overall, there was no difference in outcomes in patients who did and did not require revascularization before STSG. However, patients with diabetes were more likely to have been revascularized before STSG ($P = .005$). Increasing age also increased the likelihood of being revascularized ($P = .002$).

Finally, the logistic regression model identified only the presence of a large wound as an independent predictor for failure to heal ($P = .04$).

DISCUSSION

STSG placement has not traditionally been recommended for treating diabetic foot wounds, particularly those on the plantar, weight-bearing surface. There is a paucity of literature describing the ideal management of such wounds. Even less has been published supporting STSG placement, even though skin grafting has been performed for centuries. In 2500 to 3000 B.C., members of a Hindu

Table III. Effect of end-stage renal disease (*ESRD*) on wound healing

Variable[a]	*Patients without ESRD (n = 81)*	*Patients with ESRD (n = 13)*	P
Age, years	60.5 ± 13.3	64.2 ± 8.2	.34
Gender			
Male	57 (70.0)	8 (61.5)	.53
Female	24 (29.6)	5 (38.5)	
Location			.75
Plantar	55 (67.9)	5 (38.5)	
Nonplantar	26 (32.1)	8 (61.5)	
Wound size, cm^2	86.5 ± 149.7	49.4 ± 34.3	.66
Large wound size, >80 cm^2	19 (23.4)	2 (15.4)	.42
Follow-up duration, months	15.3 ± 7.0	16.5 ± 10.2	.71
Wound healing outcome			
Fully healed	56 (69.1)	9 (69.2)	1
Required revision	12 (14.8)	6 (46.2)	.01
Still unhealed	20 (24.6)	4 (30.7)	.35
Required amputation	5 (6.1)	0 (0)	1
Time to successful wound healing, weeks	7.6 ± 5.3	8.3 ± 6.2	.77

[a]Continuous data are shown as the mean ± standard deviation and dichotomous data as number (%).

Table IV. Benefit of revascularization on wound healing

Variable[a]	*Patients without revascularization (n = 57)*	*Patients with revascularization (n = 37)*	P
Age, years	57.7 ± 14.3	66.1 ± 7.6	.002[b]
Gender			
Male	14 (24.6)	15 (40.5)	.11
Female	43 (75.4)	22 (59.5)	
Location			.93
Plantar	38 (66.7)	25 (67.6)	
Nonplantar	19 (33.3)	12 (32.4)	
Presence of diabetes	34 (59.6)	32 (86.4)	.005[b]
Presence of ESRD	6 (10.5)	7 (18.9)	.25
Wound size, cm^2	81.3 ± 150.4	81.9 ± 126.0	.28
Large wound size, >80 cm^2	12 (21.0)	9 (24.3)	.8
Follow-up duration, months	15.4 ± 10.3	15.7 ± 9.4	.88
Wound healing outcome			
Fully healed	39 (68.4)	26 (70.3)	.85
Required revision	10 (17.5)	8 (21.6)	.78
Still unhealed	15 (26.3)	9 (24.3)	.83
Required amputation	3 (5.3)	2 (5.4)	.97
Time to successful wound healing, weeks	7.1 ± 5.7	8.7 ± 4.8	.28

ESRD, End-stage renal disease.
[a]Continuous data are shown as the mean ± standard deviation and dichotomous data as number (%).
[b]Statistically significant ($P < .05$).

tilemaker caste reportedly grafted gluteal skin to recreate a nose, and as early as 1872, Ollier and Thiersch described the technique of STSG placement.[7] However, given our own experience, supported by one other report in the literature,[5] we recommend performing STSG placement to heal chronic diabetic foot wounds. This is true even in select cases on the plantar surface.

In addition, as described in this study, we routinely use NPWT as an adjunct to prepare the wound bed before grafting and to postoperatively bolster the STSG. Advantages of using NPWT as a bolster dressing include improved graft take, ready conformance in difficult anatomic areas, ease of application, reduction in seroma and hematoma formation, and improved ability of patients to ambulate despite the dressing.[8] Moisidis et al,[9] in a randomized controlled trial, showed improved epithelialization and better STSG quality in patients who were treated with NPWT, a benefit the authors attributed to increased oxygenation at the site and continuous removal of exudate and bacteria.

Several groups have reported success in healing diabetic wounds with STSG placement. In a review of 83 diabetic patients who underwent STSG placement for foot wounds, Ramanujam et al[10] found that 65% experienced initial graft take within 7 weeks postoperatively. The grafts that failed tended to require reoperation. Graft failures were more common in smokers and in patients with a wound infection.

In a study of people with diabetes undergoing STSG placement for wound healing compared with conservative care with a standard paraffin gauze and iodine dressing, Mahmoud et al[11] found that 86% of the STSG patients healed at 8 weeks in contrast to only 46% in the conservative-care group. They also reported that more rapid healing time translated into decreased hospital length of stay and overall decreased cost of care.[11]

In a review of 107 patients undergoing STSG placement after debridement and control of diabetic foot infections, Anderson et al[12] found that the mean time to healing was 5.1 weeks, with a complication rate of only 2.8%. Puttirutvong[13] reported that meshed STSG placement yielded consistent healing in people with diabetes.

Of note, although the literature in this area is sparse, McCartan and Dinh[14] performed a meta-analysis of the few available publications on STSG placement for diabetic wounds. They computed a graft take rate of ≥90% in 78% of patients by 8 weeks, and therefore recommended it as a viable option in wound care.

In a retrospective review of ∼200 patients undergoing STSG placement for foot wounds, Ramanujam et al[5] found that comorbidities associated with diabetes, such as peripheral vascular disease, retinopathy, nephropathy, and cardiovascular disease, conferred more risk of graft failure than the diabetes itself. In the present study, we did not thoroughly evaluate patient comorbidities; however, it is possible that the graft failures we observed were in patients with a higher comorbidity index. Therefore, we now believe that, when choosing a closure method for diabetic foot wounds, it may be prudent to consider other important comorbidities and not just the presence or absence of diabetes or ESRD. This was at least partially confirmed by the higher proportion of patients with renal disease requiring revision surgery.

There are several other factors that would, at first blush, seem to play a significant role in risk for nonhealing. Two of these might include plantar location of the wound and preprocedure revascularization. Because this study was not specifically powered to identify these findings, it is entirely plausible that a prospective inquiry might show objective differences. We look forward to further works that can confirm or refute these speculations.

In the present study, we found that STSG placement enabled problematic wounds to heal successfully in many patients, although a minority did not, and a few went on to undergo an amputation. We did not look specifically into why, but many factors could contribute to these failures; the most likely causes were comorbidities, wound size, and infection. Wound size clearly played a substantial role, because wounds >80 cm^2 were less likely to heal with complete graft take. An observational study by Oyibo et al[15] reported that the greater the cross-sectional area of the wound, the more likely it was for patients to experience difficulty healing or to require amputation. Oyibo et al[15] concluded that ischemia, wound depth, and infection also negatively affected wound healing, a conclusion we previously also published.[16]

The new Society for Vascular Surgery threatened limb classification system, Wound, Ischemia, and foot Infection (WIfI), was partly designed to allow analysis of these factors critical to healing, because not only ischemia but also wounds and infection are included in WIfI and are graded for severity.[16]

Although STSG placement is a viable option to achieve wound healing, the technique does have drawbacks compared with the use of full-thickness grafts and flaps. Full-thickness grafts and flaps, for example, are more likely than STSGs to enable patients to have sensation postoperatively. STSGs also diminish the patient's ability to differentiate temperature (ie, to detect whether an object is cold or hot).[17] However, given that most patients in need of grafts are already neuropathic, lack of sensation after STSG placement is not likely to be an issue of primary concern.

Other advantages of full-thickness grafts and flaps are their tendency to be more mobile and their lower susceptibility to hyperkeratosis and fissuring than STSGs, according to Sommerlad and McGrouther.[17] However, their study described repair of the plantar foot most commonly to treat traumatic lesions; the presence of diabetes was not reported. In the present study of a primarily diabetic population with difficult-to-heal chronic wounds, we found florid hyperkeratosis surrounding STSGs to be uncommon. In sensate, nondiabetic traumatic wounds, full-thickness grafts and flaps may well be preferable; in contrast, in diabetic patients with chronic wounds, rapid primary healing might be a major therapeutic goal and, thus, STSGs might be more suitable.

For patients concerned about undergoing an operation, tissue-engineered skin grafts are another option; however, the take rate of such grafts is lower than that of autologous STSGs. One can also argue that they do not act as a graft at all, but rather as a delivery system for cytokines and chemokines. Still, tissue-engineered grafts do not require harvest and, therefore, obviate the need for and risks of anesthesia and postoperative hospitalization. The only true loss if tissue-engineered grafts fail is the cost of the graft itself and the time expended using them.[18]

CONCLUSIONS

The results of this study suggest that STSG is an effective method for management of wound healing irrespective of wound location and the presence of diabetes. The data support the use of such grafts as a viable option in the care of dorsal and plantar diabetic foot wounds. We also believe that the use of postoperative NPWT may simplify graft dressing and facilitate incorporation and healing.

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AUTHOR CONTRIBUTIONS

Conception and design: JR, JM, DA, NG
Analysis and interpretation: BN, DA, NG
Data collection: JR, JP
Writing the article: JR, JM, DA
Critical revision of the article: JR, NG, JM, BN, JP, DA
Final approval of the article: JR, NG, JM, BN, JP, DA
Statistical analysis: BN
Obtained funding: Not applicable
Overall responsibility: JR

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DISCUSSION

Dr York N. Hsiang (*Vancouver, BC, Canada*). Lower extremity wounds are different with respect to their etiologies and can at times be treated with seemingly contradictory management strategies. In this study, the authors examined 94 chronic wounds after skin grafting. The common denominators were skin grafts. Overall, 69% of patients healed their wounds with skin grafts. The authors did not explain why the other 31% did not heal. Comparisons between type and location of the ulcer showed no difference. I have the following questions:

1. What is the definition of "high-risk diabetic feet?"
2. Why were nondiabetic wounds used as the comparison group? Nondiabetic wounds, such as venous ulcers, have a different etiology, pathophysiology and prognosis compared with diabetic ulcers. So, isn't this a comparison of apples vs oranges?
3. What type of diabetic wounds were examined; were they neuropathic, mixed, or of ischemic etiologies? Presumably, the mixed and ischemic diabetic ulcers had their underlying ischemia corrected.
4. For plantar wounds, were they on a weight-bearing surface or not?
5. What were the healing rates for split-thickness skin grafts (STSGs) placed on weight-bearing compared with non-weight-bearing surfaces in diabetic patients?
6. What were the recurrence rates of these ulcers?

Dr Jessica F. Rose. Thank you very much for the questions.

1. We defined patients as "high risk" in this population that had diabetes with active wounds requiring surgical intervention. Indeed, risk for limb loss is a spectrum—ranging from the non-neuropathic low-risk patient with diabetes to a patient with severe peripheral arterial disease and ESRD. It is in part to better define this term that compelled members of our research team and other members of the Society for Vascular Surgery to create an updated threatened limb classification system for the at-risk limb based on the factors of Wound, Ischemia, and degree of Foot Infection, colloquially known as WIfI.
2. We abstracted records from our patient population undergoing STSGs to heal chronic wounds. We realize that these wounds have a very different etiology. Historically, STSGs were considered to be relatively contraindicated as a method to heal diabetic, plantar wounds. We sought to see if this population had more difficulty healing than those with other chronic wounds in a sample treated consistently by surgeons in a closely-knit clinical and research team. These patients were the logical comparison groups based on our study design. Future prospective work might allow us to draw conclusions without mixing various types of clinical fruits and vegetables.
3. We examined all different types of diabetic wounds. Those that were ischemic had the malperfusion corrected before STSG placement. We did analyze whether preoperative correction had any effect on our study population.
4. Based on our registry, we could only determine if the wounds were on the plantar surface or not, but we lacked sufficiently specific information to determine if the index wound was truly over the weight-bearing area. Therefore, those on the plantar surface were presumed to be weight-bearing. However, the essence of our interdisciplinary team consisting of vascular and podiatric surgeons, as well as orthotists and prosthetists, is to focus on spreading a potentially deleterious force out over a larger unit area. This approach mitigates pressure and, we believe, mitigates risk by increasing likelihood for healing.
5. We found that 66.7% of those with plantar wounds and 74.1% of nonplantar wounds were healed. These values were not clinically or statistically significantly different ($P = .5$)
6. We did not have any recurrences during the duration of the study. That is the subject for future works that our unit is currently undertaking. We believe strongly that durability of correction depends on a number of factors. One such factor may be the viscoelastic characteristics of skin, but just as much may be the characteristics of shoe gear modification and activity prescription.