Optimizing Skin Grafting Using Hair-derived Skin Grafts: The Healing Potential of Hair Follicle Pluripotent Stem Cells

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Abstract: *Background.* A man in his 60s with recurrent venous leg ulcers (VLUs) presented with an 18-month history of a VLU on his medial left leg measuring 59.3 cm^2. He had been treated with multicomponent compression bandages without significant decrease in ulcer size. Given the ulcer's size, refractory nature, and history of recurrence, the authors sought to optimize the patient's healing. *Methods.* Approximately 23% of the total wound was treated using punch grafts (PGs) harvested from different locations on the body based on hair density using the "stick and place" method. *Results.* One month later, a 56% reduction in ulcer size was observed, especially in the area that received hair-bearing skin. *Conclusion.* Punch grafts from hair-bearing skin are a viable source of follicular stem cells and may be superior to PG from nonhair-bearing skin for the treatment of chronic wounds.

Key words: venous leg ulcers, hair-derived skin graft, punch graft

A male patient in his 60s with recurrent venous leg ulcers (VLUs) presented to the Department of Dermatology and Cutaneous Surgery at the University of Miami Miller School of Medicine with an 18-month history of a VLU on the medial left leg. The VLU measured 59.3 cm^2 as determined by photo-planimetry (Figure 1).

Methods

Approximately 23% of the total wound was treated (13.6 cm^2 of 59.3 cm^2) using punch grafts (PGs) harvested from different locations on the body based on hair density. Area A (posterior aspect, 6.7 cm^2) received hair-bearing skin harvested from the scalp. Area C (anterior aspect, 6.9 cm^2) received nonhair-bearing skin, confirmed with the aid of dermoscopy, harvested from the upper back. The area in between, Area B, was not grafted (center of wound, 7.4 cm^2) and served as the control. This area was injured using the same technique required for the grafting technique so to assure "needling" the wound was not causal in improvement

After local anesthesia injection, PGs were obtained with a 2-mm punch biopsy and introduced using the "stick and place" method.[1] Briefly, a slit

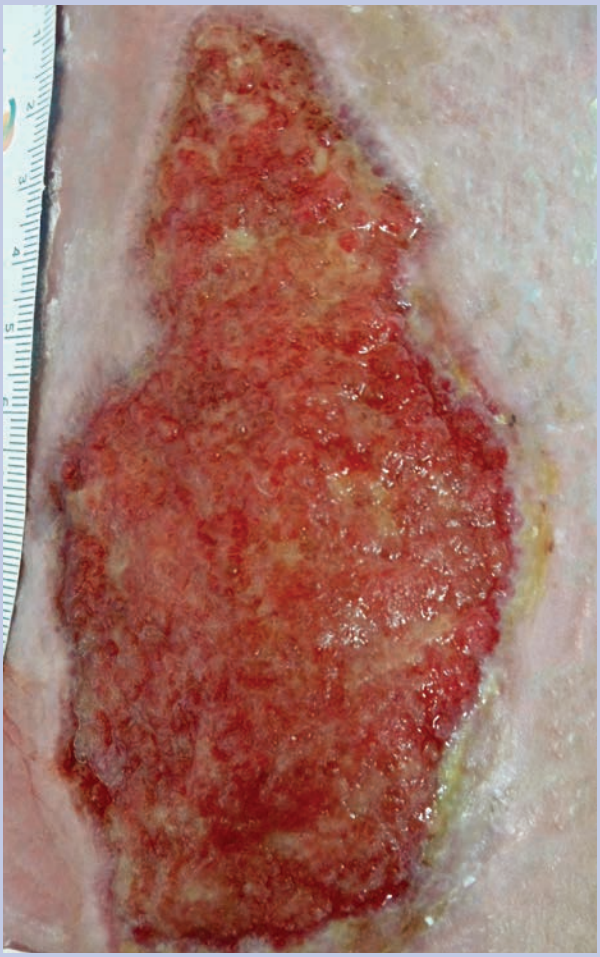

Figure 1. Venous leg ulcer before skin grafting. Full-thickness ulcer measuring 59.3 cm^2 in the medial aspect of the left lower leg.

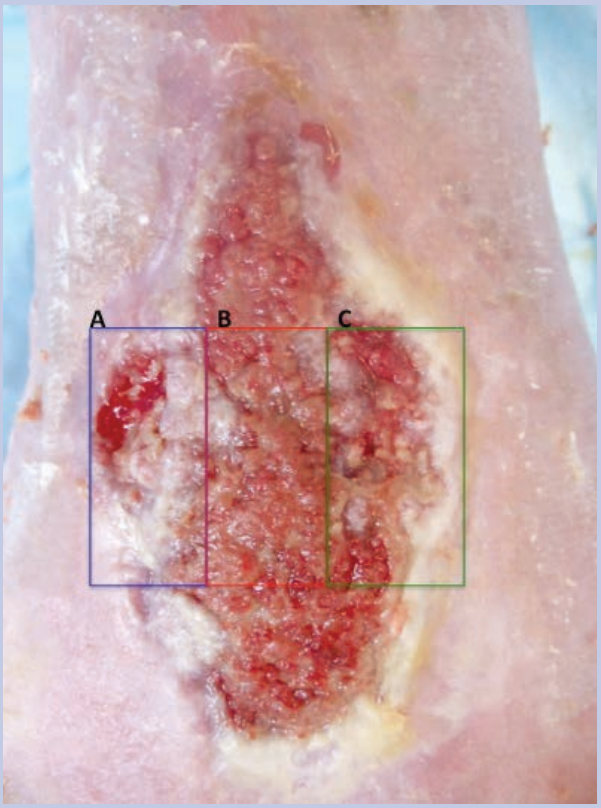

Figure 2. Venous leg ulcer 42 days after punch grafting. Ulcer size 16 cm^2, rectangles divide intervention areas. Area A (blue rectangle): Hair-bearing skin graft recipient site; Area B (red rectangle): Acute needle-wounding alone site; Area C (green rectangle): Nonhair-bearing skin graft recipient site. Graft take was observed as early as 10 days in Areas A and C. Superior and inferior aspects of wound not included in Areas A or B, and C did not receive any invasive intervention.

of 4 mm-5 mm of depth was created with a 14-gauge needle, and concurrently the PG were inserted into the slits with fine-tipped forceps. Areas A and C each received 20 grafts from the hair-bearing and nonhair-bearing donor sites, respectively (final PG density: 2.9 grafts/cm^2). Area B was punctured with the 14-gauge needle without graft placement. The ulcer was then covered with petrolatum gauze, a foam dressing, and a multicomponent compression system and changed weekly.

Results

The scalp and back donor areas healed in 1 and 2 weeks, respectively. One month later, the authors observed a 56% reduction in ulcer size, especially in the area that received hair-bearing skin.The difference was more striking after 6 weeks, when the area A wound size decreased by 91%, while total wound size decreased by 73% (Figure 2).

Hair follicles (HF) are a major reservoir of adult pluripotent stem cells (SC) and are important for re-epithelialization during wound healing.[2] Upon acute wounding, bulge SC migrate to the epidermis to aid the rapid re-epithelialization of wounded skin.[1] Tissue derived from hair-bearing skin has been utilized in wound management as cultured epidermal sheets from outer root sheath keratinocytes,[3] dermal grafts,[4] and leucine-rich repeat-containing G-protein coupled receptor 6+ follicular SC.[5] Jiménez et al[2] published a hair-grafting technique for VLUs that significantly reduced ulcer area as compared to the ungrafted control;

however, healing was not compared to skin receiving nonhair-bearing skin grafts.

Discussion

In the described patient, the advantages of using donor hair-bearing skin included rapid healing of donor and recipient areas, absence of visible scarring, and the ability to be performed as an outpatient procedure. Although the authors attempted to harvest complete HF, many grafts did not contain the lower portion. Given the predominance of SC in the HF upper portion, this probably would not affect efficacy. While the authors aimed to harvest only nonhair-bearing skin from the patient's back by using dermoscopy, they did not confirm histological HF absence; therefore, there is a possibility that the PG on the patient's back contained some HF, but in lower density.

Conclusion

In sum, PGs from hair-bearing skin are a viable source of follicular SC and may be superior to PGs from nonhair-bearing skin for the treatment of chronic wounds.

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