Epidermal Regeneration by Micrograft Transplantation with Immediate 100-Fold Expansion

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Background: Major loss of skin following burns or trauma requires skin grafting for repair. In addition, chronic wounds frequently require skin grafts. Current treatments are either cumbersome, limited in possible expansion ratio, costly, or require extensive time for treatment. This study investigates a new way of regenerating skin after major burns and other trauma, providing 100-fold expansion of a split-thickness skin graft.

Methods: Submillimeter micrografts were created by controlled mincing of a split-thickness skin graft and transplanted to porcine full-thickness wounds. By creating an incubator-like microenvironment using wound chambers, the micrografts provide reepithelialization whether placed dermal side up or dermal side down.

Results: Transplantation of micrografts in a 1:100 expansion ratio results in complete epithelialization of both healthy and diabetic wounds within 14 days. In comparison, nontransplanted wounds showed 62 percent reepithelialization in healthy pigs and 49 percent in diabetic pigs at the corresponding time point.

Conclusions: Minced skin micrografts are very effective in wound repair and can provide 100-fold expansion of a skin graft. Early clinical results confirm the utility of this technique. (Plast. Reconstr. Surg. 129: 443e, 2012.)

Major traumatic loss of skin, particularly from burns, requires skin grafting for repair.1 In a large burn, donor sites are limited and the skin grafts need to be expanded. Allografts and xenografts provide only a temporary solution.2 By meshing or mincing the skin graft, it can be expanded up to a maximum of 10-fold.3–5 Green et al.6,7 developed methods for in vitro culture of keratinocytes over 2 to 3 weeks on a feeder layer, allowing expansion of up to 1000-fold. The cultured skin could then be transferred to cover the wound in the patient. The drawbacks of cultured keratinocytes are the time of culture, cost, and fragility of the cultured skin.8–10 Meek described a technique for skin graft mincing and expansion up to 10 times.3,4 The main disadvantage with this technique is that the skin pieces have to be oriented with the dermal side down.11 Svensjö et al.12 showed that in a wet incubator–like environment, the orientation of the skin pieces is unimportant. Our hypothesis is that the skin graft can be surgically minced into submillimeter parts.

Disclosure: Dr. Eriksson is a member of a limited liability company that receives royalty payments on the sale of micrografting equipment. The remaining authors have no commercial associations or financial disclosures that might pose or create a conflict of interest.

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and transplanted to the wound in a 1:100 ratio and will regenerate the skin when provided with an optimal environment. Some of the principles of in vitro culture are used in vivo creating an in vivo tissue culture.

**MATERIALS AND METHODS**

**Animals**

The Harvard Medical Area Standing Committee on Animals approved the following study protocol. Female Yorkshire pigs (Parson’s Farm, Hadley, Mass.) weighing 50 to 60 kg were used for experiments. Pigs were allowed to acclimatize for 1 week before experiments. Eight animals were used in this study: four healthy pigs, three diabetic pigs, and one pig for long-term observation (terminal biopsy on day 123).

**Induction of Diabetes**

Pigs were fasted 12 hours before the induction of diabetes. Anesthesia was induced by means of intramuscular injection of 4 to 6 mg/kg tiletamine and zolazepam (Telazol; Fort Dodge Veterinaria, Vall de Biànya, Spain), and 2.5 mg/kg xylazine (Xyla-Ject; Phoenix Pharmaceutical, Inc., St. Joseph, Mo.). General anesthesia was maintained using 2% isoflurane (Hospira, Inc., Lake Forest, Ill.) by means of a snout mask. A venous catheter (Becton Dickinson, Franklin Lakes, N.J.) was inserted into an ear vein. Streptozotocin (Zanostar Pharmacia, Pfizer, New York, N.Y.) was prepared at a dose of 150 mg/kg body weight diluted in sterile saline (0.9% NaCl injection, USP; Baxter, Deerfield, Ill.). A transdermal fentanyl patch administering 25 μg/hour was used to manage postoperative analgesia. Serum glucose concentrations were measured on an hourly basis for the first 12 hours and twice a day for the rest of the experiment. To maintain blood glucose concentration of 350 to 550 mg/dl, subcutaneous injections of short-acting insulin (Normulin; Novo Nordisk, Princeton, N.J.) and long-acting insulin zinc suspension (Humulin; Eli Lilly, Indianapolis, Ind.) were administered. (See Figure, Supplemental Digital Content 1, which demonstrates blood glucose levels of streptozotocin-induced diabetic pigs, [http://links.lww.com/PRS/A456](http://links.lww.com/PRS/A456).)

**Skin Collection**

Under general anesthesia, the skin was depilated and cleaned with soap, 10% povidone-iodine scrub (Betadine; Purdue Products L.P., Stamford, Conn.), and 70% isopropanol. A split-thickness skin graft measuring 20 × 10 mm and 0.35 mm thick (14/1000 inch) including epidermis and upper dermis was harvested from the neck of each pig using a pneumatic dermatome (Zimmer, Inc., Dover, Ohio). The donor site of the split-thickness skin graft was healed within 8 days in all pigs.

**Surgical Mincing of Split-Thickness Skin Grafts**

Split-thickness skin grafts were washed twice in Dulbecco’s Modified Eagle Medium (Sigma-Aldrich, Steinheim, Germany) before mincing and transplantation. The mincing device consists of 24 parallel rotating cutting disks 0.8 mm apart (Xpansion Micrografting System; Wright Medical Group, Inc., Arlington, Tenn.) (Fig. 1, above). Using the device, the graft was cut twice, with the direction of the second cut perpendicular to the first. Micrografts measuring 0.8 × 0.8 × 0.35 mm were obtained (Fig. 1, below, left).

**Wounding**

After marking the 2.5 × 2.5-cm wounds in two parallel paraspinal stripes on the dorsum of the pig, outlines were tattooed with black ink using an electric tattoo marker (Spaulding & Rogers Mfg., Inc., Voorheesville, N.Y.). Full-thickness wounds down to the panniculus carnosus were excised. Wounds were separated by at least 4 cm of unwounded skin.

**Transplantation of Micrografts**

Ten micrografts, each measuring 0.8 × 0.8 mm (total surface area, 6.4 mm²), were transplanted and spread evenly over the wound bed (which had a total surface area of 645 mm²) without regard to orientation (dermal side up or down) (Fig. 1, below, right). This generated a 1:100 transplantation ratio. For illustrative purposes, two wounds were transplanted with 100 micrografts, creating a transplantation ratio of 1:10. A thin layer of medical adhesive (Hollister Inc., Libertyville, Ill.) was applied directly onto the skin surrounding the wounds, and a polyurethane wound chamber (Corium International, Grand Rapids, Mich.) was applied to cover each wound. (See Figure, Supplemental Digital Content 2, which demonstrates a polyurethane wound chamber, [http://links.lww.com/PRS/A457](http://links.lww.com/PRS/A457). Wound fluid was exchanged through the injection port using a 10-cc syringe.)

The micrografts were allowed to adhere for 1 hour before 1.5 ml of keratinocyte medium (Epilife; Invitrogen, Grand Island, N.Y.; containing human keratinocyte growth supplement, calcium-depleted serum, gentamicin, am-
Photericin, penicillin, and streptomycin) was added to the wound chamber through an injectable port. (See Figure, Supplemental Digital Content 2, http://links.lww.com/PRS/A457.)

The wound fluid was aspirated and replaced every 24 hours with 1.5 ml of saline (0.9% NaCl injection, USP) containing 100 U/ml penicillin and 100 μg/ml streptomycin. Untransplanted wounds, treated in exactly the same fashion as the transplanted wounds, served as controls.

Biopsies

Excisional full-thickness biopsy specimens of the wounds, 3 mm wide, were taken on days 6, 10, 14, 21, and 123 in healthy pigs and on days 6, 10, 14, 18, and 21 in diabetic pigs. Biopsy specimens were excised diagonally to cover the whole wound width. At the end of the experiment, pigs were euthanized using intravenous injection of 8 ml of barbiturate (Euthasol; Virbac AH, Inc., Fort Worth, Texas).

Histologic Evaluation

Biopsy specimens were fixed in 10% formalin solution, embedded in paraffin, and cut into 6-μm-thick sections. After rehydration, slides were stained with hematoxylin and eosin or Masson trichrome for routine histologic evaluation. Reepithelialization, thickness of epidermis, and number of rete ridges were evaluated in hematoxylin and eosin–stained slides using an Eclipse E400 light microscope (4×/0.10, 10×/0.25, and 40×/0.65), Digital Sight camera, and NIS-Elements D3.0 digital image analysis system (Nikon Corp., Kanagawa, Japan). Reepithelialization was expressed as percentage epithelialized length over total length of the wound biopsy specimen. Epidermal thickness was measured in five random locations along the wound diameter. The number of rete ridges per millimeter wound was counted in five random sections of reepithelialized wounds.

Immunohistochemistry

Statistical Analysis

Statistical comparisons were performed using nonparametric Kruskal-Wallis tests with Dunn multiple comparison post tests. Values of $p < 0.05$ were considered statistically significant. All statistical analyses were performed using GraphPad Prism 5.0 (GraphPad Software, Inc., La Jolla, Calif.). All results are given as mean $\pm$ SD unless otherwise noted.

RESULTS

Reepithelialization following Micrograft Transplantation in a 1:100 Expansion Ratio

With 0.8 $\times$ 0.8-mm micrografts and an expansion of 100-fold (1 percent initial coverage), the distance between micrografts was approximately 6 mm. Fibrin formation secured the micrografts to the base of the wound (Fig. 2, above, left). The wound space was filled with a blood clot after 24 to 48 hours. Biopsy specimens on day 6 showed that the blood clot had turned into granulation tissue and the transplanted micrografts had moved approximately half the distance (5 mm) to the wound surface (Fig. 2, above, second from left). On day 10, the micrografts had become incorporated at the wound surface. While migrating from the base of the wound to the surface, the keratinocytes of the grafts seemed to expand radially in all directions from the exposed surface area of the skin micrograft. Once reaching the surface, the keratinocytes proliferated horizontally across the wound surface, participating in reepithelialization. During the migration of the micrograft to the wound surface, the stratum corneum gradually separated from the proliferating keratinocytes, as did the transplanted dermis. The transplanted stratum corneum and dermis reached the wound surface and were expelled through the epidermis (Fig. 2, above, second from right and above, right). A schematic illustration of micrograft movement and proliferation is provided in Supplemental Digital Content 4. (See Figure, Supplemental Digital Content 4, http://links.lww.com/PRS/A459).

Full-thickness diagonal biopsy specimens from postoperative days 6, 10, and 14 were stained with hematoxylin and eosin and evaluated for epider-

![Figure 2](http://links.lww.com/PRS/A459)
mal regeneration. On day 6 after transplantation, we found no statistical difference in epidermal regeneration between the transplanted and the untransplanted wounds. One possible reason is that the micrografts were still in the process of migration through the provisional matrix and had not yet reached the wound surface (Fig. 2, above, second from left). The epithelial ingrowth from the wound borders was similar in both groups, covering 11.6 ± 4.1 percent (mean ± SD) of the wound surface in the transplanted group and 13.7 ± 3.6 percent in the untransplanted group. On day 10, the proliferating micrografts had reached the wound surface and made a detectable contribution to the epidermal regeneration. The transplanted wounds showed 81.6 ± 9.7 percent regenerated surface area compared with 42.6 ± 7.2 percent in untransplanted controls (p < 0.005). On day 14, all transplanted wounds were 100 percent healed, as compared with only 62.5 ± 9.8 percent of the surface area in the control wounds (p < 0.005) (Fig. 3).

Dermal Component of Transplanted Micrografts

Sections were analyzed for collagen content using trichrome staining. [See Figure, Supplemental Digital Content 5, which demonstrates trichrome staining of wounds, http://links.lww.com/PRS/A460. (Above, left) Trichrome staining of a micrograft in a wound 6 days after transplantation. The dermal component of the transplanted micrograft is stained blue (bar = 200 μm). (Above, right) Trichrome staining of micrografts in a wound 14 days after transplantation displaying the expulsion of the dermal component through the epidermis (bar = 100 μm). (Center) Trichrome staining of a diagonal section of a fully healed wound 14 days after transplantation. Positively stained areas are visible in the center of the healing wound. (Below) Trichrome staining of a diagonal section of a wound 123 days after micrograft

![Fig. 3. Proliferating cells in the micrograft, basement membrane, and subepidermal blood vessel staining. Consecutive sections of wound transplanted with micrografts stained with hematoxylin and eosin (above, left), Ki-67 (above, center), and pancytokeratin (above, right). MD, micrograft dermis; MSC, micrograft stratum corneum. The Ki-67 proliferation assay (above, center) shows pronounced activity in the basal layer of the micrograft, and the pancytokeratin assay (above, right) confirms that the proliferating cells are keratinocytes. (Below, left) Collagen IV antibody staining revealed well-developed basement membrane next to the micrografs, separating the proliferating keratinocytes from the fibroblasts. (Below, right) Von Willebrand factor antibody staining on wounds 14 days after transplantation shows newly formed blood vessels creating a subepidermal plexus (bar = 400 μm in above, left and below, right).](http://links.lww.com/PRS/A460)
transplantation showing clear differentiation between scar tissue and unwounded dermis (bar = 300 μm in center and below).]

This revealed the transplanted collagen-rich dermal component being expelled through the epidermis 14 days after transplantation. Furthermore, positively stained areas could be observed within the granulation tissue on the same day. Trichrome staining of wounds 123 days after transplantation showed a clear differentiation between scar tissue and unwounded dermis in transplanted and untransplanted wounds. (See Figure, Supplemental Digital Content 5, center and below, http://links.lww.com/PRS/A460.)

At this time point, no difference between the two groups was observed. Transplanted and untransplanted wounds from day 123 were initially treated in a moist environment for 21 days (until closure) to provide consistent basic conditions for comparison.

**Proliferative Cells in the Micrografts**

Antibodies directed toward Ki-67 were used to assess proliferation of cells adjacent to the transplanted micrografts (Fig. 3, above, center). Stained cells were present in the basal epithelial area of the micrografts and confirmed to be keratinocytes by pankeratin antibody staining (Fig. 3, above, right).

**Number of Blood Vessels in the Subepidermal Plexus**

The number of blood vessels in wounded tissue was assessed in biopsy specimens from healthy pigs by immunohistochemistry using antibodies directed against the endothelial marker von Willebrand factor. On day 10, there were 3.0 ± 0.16 vessels/mm² in the subepidermal plexus of the transplanted wound compared with 1.7 ± 0.48 in the control wounds (p < 0.005). On day 14, the corresponding numbers were 3.3 ± 0.72 and 2.2 ± 0.65 vessels/mm² in experimental and control wounds, respectively (p < 0.05). In unwounded skin, we found 1.6 ± 0.44 vessels/mm² (Fig. 4). No statistical difference was observed in wounds 21 or 123 days after transplantation.

**Basement Membrane and Number of Rete Ridges**

Immunohistochemistry with a collagen IV antibody identified basement membrane separating proliferating epithelial and mesenchymal components as early as 6 days after transplantation. On days 10 and 14, the basement membrane had reached the wound surface together with proliferating groups of keratinocytes. On day 14, the basement membrane was continuous in the

![Fig. 4. Graphs illustrating skin integrity, vascularization of the subepidermal plexus, wound contraction, and epithelial thickness.](http://links.lww.com/PRS/A460)

Regarding the dermal-epidermal junction (left), no significant differences were observed on days 21 or 123 between the transplanted and the untransplanted groups. On both 21 and 123 days after transplantation, the number of rete ridges was significantly lower than in healthy skin, with the exception of transplanted wounds at day 21. Regarding vascularization of subepidermal plexus (center), there was a significantly higher number of vessels on days 10 and 14 in the transplanted group compared with untransplanted and unwounded skin. Vascularization was increased in the transplanted group in the early stages of wound healing. Regarding epidermal thickness (right), the epithelium in the transplanted group 21 days after transplantation had a mean thickness of 184.8 μm, whereas the nontransplanted control group’s corresponding thickness was 142.4 μm. The mean thickness of unwounded epidermis was 116.2 μm. On day 123, the thickness of the epithelium was lower in the transplanted and control wounds compared with unwounded skin (*p < 0.05; **p < 0.005).
wounds treated with skin micrografts (Fig. 3, below, left). The number of rete ridges per linear millimeter has often been used as an indicator of the strength of the dermal-epidermal junction. In healthy normal pig skin, we found 7.6 ± 1.8 rete ridges per millimeter. Twenty-one days after transplantation, there was no statistically significant difference between transplanted wounds (5.7 ± 1.9 rete ridges per millimeter) and normal skin. Untransplanted wounds displayed a significantly lower number of rete ridges (4.7 ± 1.6 rete ridges per millimeter) than normal skin (p < 0.01). On day 123, the number of rete ridges in the regenerated epithelium was 4.6 ± 1.4 in micrograft-transplanted wounds and 4.2 ± 1.9 in untransplanted wounds (Fig. 4); both were significantly lower than that of normal skin.

Epidermal Thickness

On day 21, the epidermis in the healed transplanted wounds (184.8 ± 45.4 μm) was not significantly thicker than in healed untransplanted wounds (142.5 ± 32.7 μm) but was significantly thicker than the epidermis of normal unwounded skin (116.2 ± 21.9 μm) (p < 0.005). In biopsy specimens from day 123, all three groups had epidermis of similar thickness (Fig. 4).

Wound Contraction

At the time of wounding, wound borders were tattooed with India ink. The initial surface area of the wounds was 625 mm². At days 21 and 123, the surface area of transplanted and control wounds was measured using computer planimetry. [See Figure, Supplemental Digital Content 6, which demonstrates macroscopic appearance of wounds, http://links.lww.com/PRS/A461. (Left) Macroscopic photograph of a wound 14 days after transplantation of micrografts in a 1:100 expansion ratio. Transplanted micrografts are visible on the reepithelialized wound surface. (Center) Macroscopic photograph of a nontransplanted wound at the corresponding time point (bar = 500 μm). (Right) Bar chart comparing wound contraction. Transplanted wounds displayed a smaller wound surface area at both studied time points as compared with untransplanted controls. These differences were not statistically significant.]

In micrograft-transplanted wounds of healthy pigs, the wound surface area was 295.9 ± 30.5 mm² on day 21 and 308.3 ± 57.7 mm² on day 123. In untransplanted control wounds, the surface area was 231.9 ± 31.3 mm² on day 21 and 241.9 ± 53.0 mm² on day 123. None of these differences reached statistical significance.

Reepithelialization by Micrograft Transplantation in a Diabetic Wound Healing Model

Similar micrograft transplantation experiments were performed in a previously established impaired wound healing model by inducing diabetes with streptozotocin in three pigs. Two weeks after induction of diabetes, full-thickness wounds were created on the dorsum of the pigs. Wounding and micrografting procedures were performed as described above in healthy pigs. Full-thickness diagonal biopsy specimens were taken on days 6, 10, 14, 18, and 21. Evaluation of reepithelialization showed that the surface of the transplanted wounds was 77.9 ± 10.9 percent regenerated by day 10 compared with 28.9 ± 4.6 percent in untransplanted wounds (p < 0.005). By day 14, transplanted wounds were fully epithelialized. We found that the untransplanted wounds were 28.9 ± 4.6 percent epithelialized on day 10, 49.1 ± 11.4 percent epithelialized on day 14, 87.1 ± 7.1 percent epithelialized on day 18, and fully healed by day 21 (Fig. 5), 1 week later than the transplanted wounds. The migration and proliferation process of the transplanted micrografts was similar to the observations made in healthy pigs.

DISCUSSION

Svensjö et al., in an effort to avoid the need for keratinocyte culture, started to use mechanical mincing to produce small pieces of skin containing both epidermis and dermis to be immediately available after the skin graft harvesting with minimal manipulation. Using a wound chamber, which provided an in vivo tissue culture environment, the minced pieces of skin proliferated, expanded, and provided new epidermis. In the present study, the methodology has been further developed by using a standardized skin dermatome and mincer that allowed us to create uniform micrografts defined to geometric size and dermal and epidermal thickness (Fig. 1, below). Contrary to current surgical practice, we found that within a moist environment the micrografts contribute to reepithelialization of the healing wound regardless of orientation (dermal side up or down). The wound chamber provides an in vivo incubator-like environment, where the early substrate for the proliferating micrografts is the wound fluid. Early clinical applications indicate that this also applies when using micrografts in combination with moist
dressings. Compared with previously published data on split-thickness skin grafts, results presented in this study show that full-thickness wounds transplanted with micrografts in a 1:100 ratio produced similar results regarding time needed for full reepithelialization. This was true also for the impaired wound healing model in streptozotocin-induced diabetic pigs (Fig. 5). The micrografts seem programmed to move to form epidermis at the same level as the surrounding skin (Fig. 2, below). The dermal part of the transplanted micrografts was observed to be expelled through the epidermis, but trichrome staining revealed collagen present in the center of the healing wound. (See Figure, Supplemental Digital Content 5, http://links.lww.com/PRS/A460.) This implies that the micrografts are contributing to dermal regeneration. Several publications suggest the importance of regenerating the dermal component to ensure optimal wound healing. Commonly used split-thickness skin grafts provide proliferating keratinocytes mainly from the borders of the graft. Findings presented in the current study imply that keratinocytes from the micrograft proliferate not only from the borders and the skin appendages, but also from the basal layer (Fig. 3, above, center). Proliferation in the basal layer and from the epidermis at the borders of the micrograft (the length of which increases with decreased micrograft size) allows for greatly increased micrograft expansion. Transplantation of micrografts seems to stimulate blood vessel formation in the subepidermal plexus during reepithelialization. Later during healing, this increase is diminished, and the number of vessels becomes similar to that of normal skin. This early hypervascularity seems beneficial to the wound healing process, providing oxygen and nutrients to the proliferating tissue. Moreover, early vascularization of the wound appears to diminish the incidence of infection. Patients suffering from major skin trauma and burns suffer from increased fragility of the healed skin, with blistering and frequent open wounds. This susceptibility to trauma and shear appears to be present after healing of deep partial-thickness wounds and after transplantation with split-thickness skin grafts and particularly after transplantation with cultured epithelial autografts. The weakness of the dermal-epithelial junction is generally considered attributable to poor development of rete ridges. The micrograft-transplanted wounds had a more normal dermoepidermal junction in terms of number of rete ridges per linear millimeter as compared with the wounds that had healed without transplantation (Fig. 4). Moreover, it was found that new basement membrane was formed in the proliferating micrograft as early as 6 days after trans-

**Fig. 5.** Bar charts showing reepithelialization of healthy (left) and diabetic wounds (right). Healthy wounds display accelerated healing in the transplanted group, with a significantly higher epithelialization rate on day 10 (81.6 percent) compared with the control wounds (42.6 percent). The difference remains significant on day 14, when all transplanted wounds were reepithelialized compared with 62.5 percent of the nontransplanted controls. Similar results were observed in streptozotocin-induced diabetic pigs, with a significant difference on day 10: 77.9 percent reepithelialization in the transplanted group and 28.9 percent in the untransplanted control wounds. Transplanted wounds were 100 percent reepithelialized by day 14 compared with 49.1 percent in nontransplanted diabetic controls. The nontransplanted controls were completely reepithelialized on day 21 (*p < 0.05; **p < 0.005; n = 4 to 7).
plantation as detected by collagen IV antibody staining (Fig. 3, below, left). Once the micrografts reach the surface, the segments of basement membrane from different micrografts fused to form a continuous dermal-epidermal junction. The combination of a high number of rete ridges and basement membrane formation in wounds transplanted with micrografts suggests that the regenerated skin possesses increased mechanical stability because of a greater surface area for anchoring protein attachments.29 Moreover, micrograft-transplanted wounds displayed a thicker neoeipidermis 21 days after transplantation, indicating a stronger skin integrity.12,30

The described micrografting technique provides a possible solution to multiple problems in burn treatment, by enabling complete coverage of large defects (total body surface area >50 percent) without the need for repeated skin harvest from a single donor site or keratinocyte culture expansion. The described principles and techniques for micrografting differ from those of Meek and others in some major aspects. First, it can provide a 100-fold (compared with 10-fold with Meek’s technique) expansion when transplanted to full-thickness wounds. Second, orientation of the grafts does not matter, whereas it is essential with Meek’s technique. Third, the micrografts contain epidermis and dermis and could therefore potentially be used as a therapy in third-degree burns and full-thickness wounds as opposed to, for example, cell spray techniques, which are recommended for use only in partial-thickness wounds, unless supplemented with additional wound care products. Moreover, the findings in the impaired wound model suggest the potential use of the micrografting technique in chronic wounds with a minimum amount of donor-site defects.

Early clinical results confirm the utility of this technique. Danks and Lairet published a case report of a civilian patient with a 54 percent total body surface area burn admitted to a U.S. Army military hospital in Iraq and successfully treated with the described micrografting technique. This patient is believed to be one of only a few to survive such a large burn injury outside of a specialized burn care center.18

CONCLUSIONS

This study presents a new paradigm for transplantation and regeneration of skin. Besides the possible clinical utility of the micrografting technique, the reported findings should prove useful not only for understanding the process of regeneration but also for tissue engineering and transplantation of skin.

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