Early Escharectomy and Concurrent Composite Skin Grafting over Human Acellular Dermal Matrix Scaffold for Covering Deep Facial Burns

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Background: Although escharectomy and full-thickness skin autografting have been widely used to treat deep facial burns, the clinical outcomes remain unacceptable. Composite razor-thin skin grafting over acellular dermal matrix scaffold has been used successfully in repairing burns of the trunk and limbs, but its use in covering deep facial burns has rarely been reported. In this study, the authors investigated the clinical outcomes of early escharectomy and concurrent composite razor-thin skin autografting and acellular dermal matrix scaffold for treating deep facial burns.

Methods: Patients with deep facial burns ($n = 16$) involving 8 to 30 percent of the total body surface area received early escharectomy by postburn day 3 and concurrent, one-stage, large, razor-thin skin autografting on top of human acellular dermal matrix scaffold. Wound dressings were changed on postoperative days 7, 9, and 12 to examine the survival of skin autografts. Patients were followed up for 12 months to evaluate their facial profiles.

Results: The take rate of composite skin autografts was 97.3 percent at postoperative day 12. At the follow-up visit, the skin autografts appeared normal in color, with soft texture and good elasticity. The skin junctures showed little scarring. The patients exhibited a chubby facial appearance and abundant expression, except for one patient with microstomia and two patients with ectropion who required further plastic surgical interventions.

Conclusion: Early escharectomy and concurrent composite razor-thin skin autografting on top of acellular dermal matrix scaffold constitute an effective and favorable option for covering deep facial burns, especially for patients with limited donor sites. (*Plast. Reconstr. Surg.* 127: 1533, 2011.)

The treatment of deep facial burns remains challenging in clinical practice. Early escharectomy and skin autografting have been used with some favorable outcomes, although palpebral, nasal, and oral malformations frequently occur postoperatively, as do pigmentation of skin autografts and hyperplasia of graft junctures.[1,2] Moreover, the adequate source for skin autografting is not necessarily available for thick grafting in patients with burns covering a large body surface area, and taking skin for autografting causes additional scars at the harvest sites. Thus, a novel and effective modality is always being sought with which to repair burn wounds with fewer skin autografts and fewer malformations.

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Acellular dermal matrix is the mixture of dermal elastin and collagen free of cellular components. It is being used increasingly for repair and reconstruction of congenital and traumatic defects, including

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burns, especially those involving hands and joints.[3–5] Burn wounds treated with escharectomy followed by co-grafting of acellular dermal matrix and ultrathin split-thickness (0.1 to 0.2 mm) skin autografts will not cause additional scars at the harvest sites.[6] Such a regimen is also helpful for the repeated harvesting of skin autografts in patients with burns over a large area of the body.

We successfully treated the deep burns of bilateral upper extremities by using composite razor-thin skin autografts on top of acellular dermal matrix.[7] The combination of acellular dermal matrix and razor-thin skin autografts provided a thickness equal to the thick split-thickness autograft, and it did not cause excessive scars and subsequent contracture. The use of acellular dermal matrix in one-stage composite razor-thin skin autografting did not compromise the survival of skin autografts. The use of acellular dermal matrix has rarely been reported in treating deep facial burns. Therefore, in this study, we examined the clinical outcomes of early escharectomy and concurrent composite razor-thin skin autograft and acellular dermal matrix.

PATIENTS AND METHODS

Preoperative Management

The study protocol was approved by the Institutional Review Board of The First Affiliated Hospital of Sun Yat-sen University, and informed consent was obtained from all participants. A total of 16 patients consecutively hospitalized with deep facial burns from 2006 to 2009 were enrolled in this study. At admission, the depth and total body surface area of the burn were evaluated by a single attending plastic surgeon specializing in burn care. All eligible patients were diagnosed with third-degree facial burns and were able to tolerate the surgical intervention in acceptable general condition (Fig. 1, *above, left*). [**See Figure, Supplemental Digital Content 1,** which shows a 38-year-old woman with third-degree burns of 15 percent total body surface area from sulfuric acid, ***http://links.lww.com/PRS/A302***. (*Above, left*) The wound after early facial escharectomy (tangential excision) on postburn day 3. (*Above, center*) One-stage grafting with human acellular matrix by area. (*Above, right*) Grafting with composite razor-thin skin autografts. (*Below, left*) Third-degree facial burns before surgical procedure. (*Below, right*) The patient 12 months after early escharectomy and concurrent composite razor-thin skin grafting.] [**See Figure, Supplemental Digital Content 2,** which shows a 48-year-old man with third-degree burns of 10 percent total body surface area from sulfuric acid, ***http://links.lww.com/PRS/A303***. (*Left* and *center*) Third-degree facial burns before surgery. (*Right*) Twelve-month postoperative view after early escharectomy and concurrent composite razor-thin skin grafting.] Preoperative topical povidone-iodine ointment (QingFa Pharmaceutical Co., Ltd., Guangdong, China) was given routinely.

Surgical Procedure

All 16 patients received escharectomy and acellular dermal matrix plus grafting by postburn day 3 (48.7 ± 4.5 hours). The facial surface area receiving escharectomy and skin autografting was 2.0 ± 0.6 percent. A Goulian dermatome was used to remove all of the eschars and necrotic tissues until normal tissues were visible (Fig. 1, *above, right*). (**See Figure, Supplemental Digital Content 1, *http://links.lww.com/PRS/A302***.) The combination of bipolar electrocautery and epinephrine-soaked (1:10,000) Telfa pads (Covidien, Mansfield, Mass.) was used for hemostasis. Commercialized human acellular dermal matrix was purchased from Jie-Ya Life Tissue Engineering (Beijing, China), which was approved by the Chinese State Food and Drug Administration for human use. Acellular dermal matrix was implanted onto the posteschar ectomic wounds as a scaffold (Fig. 1, *below, left*). (**See Figure, Supplemental Digital Content 1, *http://links.lww.com/PRS/A302***.) Large unmeshed razor-thin skin autografts (0.20 mm) were harvested with a Zimmer dermatome (Zimmer Orthopaedic Surgical Products, Inc., Dover, Ohio) from the anterolateral side of unaffected thighs to cover the acellular dermal matrix implants. The razor-thin skin autografts formed a close and neat junction and were further secured with fibrin glue over the acellular dermal matrix (Fig. 1, *below, right*). (**See Figure, Supplemental Digital Content 1, *http://links.lww.com/PRS/A302***.) Dressings consisted of Vaseline gauze (Jelonet; Smith & Nephew Medical Limited, Hull, England), cotton pads, and pressure bandages (Nylexogrip; Laboratories Urgo, Chenover, France). The entire procedure lasted 1.9 ± 0.8 hours on average.

Postoperative Care

Eye, nasal, and oral care was given postoperatively. Patients fasted until postoperative day 7, when they were fed parenterally or through a nasogastric tube. Wound dressings were changed on postoperative days 7, 9, and 12 to observe the presence or absence of hematomas and to evaluate the take rates of the composite skin autografts.

Fig. 1. Surgical procedure of co-grafting with human acellular dermal matrix and large razor-thin skin autografts. (*Above*, *left*) A 43-year-old man sustained third-degree burns of 20 percent total body surface area from sulfuric acid. (*Above*, *right*) Early facial escharectomy (tangential excision) on postburn day 2. (*Below*, *left*) One-stage grafting with human acellular matrix by area. (*Below*, *right*) Grafting with composite razor-thin skin autografts.

Pressure garments and elastic masks (Cica-Care; Smith & Nephew Medical Limited) were prescribed for the patients for 6 to 12 months. Patients were followed up for 12 months after discharge from the hospital. Skin autografts were evaluated at 16 follow-up visits for their color, appearance, texture, elasticity, scars at the junctures, and blebs. The cosmetic appearance was evaluated by independent surgeons, in addition to the patient self-reported satisfaction.

RESULTS

Table 1 summarizes the patients' characteristics. The burn surface area ranged from 8 to 30 percent of the total body surface area. All patients were afflicted with third-degree burns, and their facial wounds involved 2 percent ($n = 10$) and 3 percent ($n = 6$) of the total body surface area, respectively. The causes of the burns were either flames ($n = 4$) or chemicals, including acids ($n = 11$) and alkalis ($n = 1$).

Table 1. Patient Characteristics and Complications (*n* = 16)

Patient	Sex	Age (yr)	Cause	% TBSA	Take Rate (%)	Complication
1	Male	40	Flame	30	97	None
2	Male	38	Acid	12	97	Ectropion
3	Male	28	Flame	30	98	None
4	Male	53	Acid	8	99	None
5	Female	42	Alkali	26	96	Microstomia
6	Male	56	Acid	18	96	SSI
7	Female	18	Flame	20	99	None
8	Female	22	Acid	15	98	None
9	Male	32	Acid	10	97	None
10	Male	43	Acid	20	97	None
11	Male	46	Acid	22	96	Ectropion
12	Male	20	Acid	20	98	None
13	Male	55	Acid	8	99	None
14	Female	38	Acid	15	96	None
15	Male	40	Flame	25	97	None
16	Male	48	Acid	10	97	None

TBSA, total body surface area; *SSI*, surgical-site infection.

On postoperative day 12, the take rate of composite skin autografts was 97.3 ± 1.1 percent (Fig. 2, *left*). Physical examination revealed that none of the patients developed hemorrhage or hematoma. At the 12-month follow-up visit, the cosmetic results were rated as "satisfactory" by both patients and independent surgeons. The skin autografts appeared normal in color and were comparable to the surrounding skin, with soft texture and good elasticity. Hypertrophic scarring was not identifiable in recipient sites. The skin junctures showed little scarring, and no blebs were detected. The patients exhibited a chubby facial appearance and abundant expression (Fig. 2, *right*) (**See Figures, Supplemental Digital Content 1, *http://links.lww.com/PRS/A302***, and **Supplemental Digital Content 2, *http://links.lww.com/PRS/A303***), except for one patient with microstomia and another two patients with ectropion; these three patients received further plastic surgical interventions.

DISCUSSION

Facial burn is a common trauma. In cases in which facial burns do not heal within 2 to 3 weeks or in patients covered with thin split-thickness skin grafts on granulation tissue, treatment outcomes are disappointing and can directly impact the patient's quality of life. Such outcomes remain as a long-term refractory condition requiring plastic surgery.[1,8–10] Surgery is universally recommended for deep burns of the face. Nevertheless, outcomes following excision and grafting are not perfect. Moreover, in cases of extensive burns, it may be difficult to find adequate donor sites from which to harvest thick autografts.

Acellular dermal matrix has been used successfully in the treatment of full- and partial-thickness burn injuries and in late reconstruction. Acellular dermal matrix has also been shown to be suitable for the functional reconstruction of burns of the hand because of their tender texture. Moreover, the com-

Fig. 2. The postoperative facial profiles of the patient shown in Figure 1. (*Left*) On postoperative day 12, all of the composite autografts had survived the transplantation. (*Right*) At the 12-month follow-up visit, the patient exhibited normal facial appearance, with nearly normal color and good elasticity compared with normal skin and without excessive scars.

bination of acellular dermal matrix and razor-thin skin autografting can provide a thickness equal to that of the thick autograft. However, the use of acellular dermal matrix following early facial escharectomy has rarely been reported.

Our findings justified the use of acellular dermal matrix in treating deep facial burns. Long-term follow-up results confirmed its efficacy in terms of gross appearance. The skin autografts on top of the acellular dermal matrix scaffold appeared normal in color and comparable to the surrounding skin. The texture was supple, the elasticity was good, and hypertrophic scarring did not occur. Usually, the junctures between skin grafts and between grafts and ungrafted skin were among the blotchiest features of the skin-grafted face. However, we found that the skin junctures were barely visible in patients treated with acellular dermal matrix and grafts. The patients generally exhibited a chubby facial appearance and abundant expression.

Thus, such autografting on top of an acellular dermal matrix scaffold could be an alternative to thick or full-thickness skin autografting in facial burn treatment without the increased risks of facial scarring and contracture. Moreover, harvesting of razor-thin skin autografts minimized scarring at both the graft source and its recipient area, which would be beneficial to patients with extensive burns who required repeated harvesting from donor sites to achieve complete wound coverage.

In our study, we showed that a one-stage procedure was possible without compromising the take rate of autografts. In comparison with two-stage grafting, one-stage composite razor-thin skin autografting on top of acellular dermal matrix scaffold shortened the wound healing and hospitalization time, allowing patients to resume physical exercises earlier.

Prompt closure of burn wounds is key to the successful treatment of patients with extensive burns. Early escharectomy and favorable coverage minimizes the risks of infection and speeds up wound healing.[11] In our study, all 16 patients underwent facial escharectomy and the subsequent composite skin autografting over acellular dermal matrix by postburn day 3 (48.7 ± 4.5 hours). Our escharectomy was radical, in which we did not preserve tissues suspected of being devitalized. The overall take rate was 97.3 percent.

Three of 16 patients developed facial deformity in our study: one had microstomia and another two had ectropion. This result indicated the nonsuperiority of razor-thin autografting on acellular dermal matrix scaffold to thick or full-thickness autografting. We felt that the texture of razor-thin autografting over acellular dermal matrix was quite favorable but that it was not as supple as that of the thick autograft. Because composite autografts are less favorable regarding plasticity, thick or full-thickness autografts are preferred for eyelid wounds.

Hemostasis is an independent factor involved in the outcome of facial escharectomy with composite skin autografting. The facial area is well vascularized,

CODING PERSPECTIVE

This information prepared by Dr. Raymond Janevicius is intended to provide coding guidance.

15120	Split-thickness skin graft, face, first 100 cm^2
15121	Split-thickness skin graft, face, additional 100 cm^2
15121	Split-thickness skin graft, face, additional 100 cm^2
15004-51	Tangential excision facial burn, first 100 cm^2
15005	Tangential excision facial burn, additional 100 cm^2
15005	Tangential excision facial burn, additional 100 cm^2
15330-51	Acellular dermal allograft, first 100 cm^2
15331	Acellular dermal allograft, additional 100 cm^2
15331	Acellular dermal allograft, additional 100 cm^2

- The coding assumes 300 cm^2 of burn excised and grafted.
- The tangential excision of the burn (escharectomy) is reported with codes 15004 and 15005. This is a "surgical preparation" of a wound in preparation for grafting. The débridement codes (1104X) are not appropriate here.
- Placement of the acellular dermal allograft is reported with codes 15330 and 15331.
- Split-thickness skin grafting, regardless of graft thickness, is reported with codes 15120 and 15121.
- All these codes are reported in 100-cm^2 increments.
- Codes 15121, 15005, and 15331 are add-on codes and do not take the multiple procedure modifier, –51. Reimbursement should be at the full allowable.

and refractory hemorrhage frequently occurs in the process of escharectomy, leading to failure of subsequent skin autografting.[12] To address this issue, we used a combination of multiple hemostatic regimens, including preoperative administration of coagulants, intraoperative bipolar electrocautery, and the local use of epinephrine.

SUMMARY

For patients with deep facial burns, early escharectomy and concurrent composite skin autografting over acellular dermal matrix should be performed in patients with acceptable general conditions and the absence of serious complications. Such a plastic surgery modality can produce favorable outcomes, with accelerated wound healing and shortened hospitalization.

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PATIENT CONSENT

Patients provided written consent for the use of their images.

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