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Successful treatment of a patient with an extraordinarily large deep burn

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D Data Interpretation
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Summary

Background: Treatment of extraordinarily large deep burns remains a huge clinical challenge.

Case Report: This article is a summary of our experience with the treatment of a patient with an extraordinarily large deep burn (99.5% TBSA and 23% fourth degree burn) by using the "microskin autografting and alloskin repeated grafting" method to close the deep burn wound because of scarcity of skin sources of the patient.

Conclusions: The patient has been observed for 2 years, and is able to face the reality of life peacefully with the support of his family.

key words: **deep burn wound • burn operation • Quality of Life**

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Background

The salvage rate of large burns has improved steadily in the past 10 years in China [1]. However, in patients with a scarcity of skin sources, treatment of large fourth degree burns remains a great clinical challenge [2]. For extensive severe burn wounds repair, there are 3 major solutions: MEEK skin grafting, Chinese-originated micro-skin autografting, and transplantation of cultured epidermal cells. MEEK skin grafting can expand the donor skin by 3–9 times, and micro-skin autografting can do this 10–15 times larger. Therefore, micro-skin autografting is more suitable for application to severely burned patients who have a scarcity of skin sources. Autologous transplantation of cultured keratinocytes can provide adequate skin sources for wound closure, but the long cultivation time, high cost and rigorous technology requirements limit its application in developing countries. Even though the patient is saved, the patient's quality of life remains an increasing concern, both on the part of clinicians and society. This article is a summary of our experience with the treatment of a patient with an extraordinarily large deep burn (99.5% TBSA and 23% fourth degree burn) by using the "microskin autografting and alloskin repeated grafting" method to close the wound because of scarcity of skin sources. The patient was observed for 2 years, and the quality of life is evaluated.

Case Report

The patient is a 29-year-old male who was seriously burned by molten steel (about 1,500°C) from the top of the head throughout the body, in an accidental furnace explosion. Thirty hours after fluid resuscitation in a local hospital, he was referred to our hospital, when the patient was conscious and the vital signs were relatively stable. Except for a small piece of unburned skin on the posterior head measuring about 0.5% TBSA, the rest of the scalp and the face suffered deep second degree burns, and the trunk and the 4 extremities were full of black eschar. When the 4 extremities were incised to reduce tension, muscular eversion and necrosis were seen in part of the median sides of the upper limbs and thighs, and lateral sides of the calves, the left arm being the most serious. The fingers of both hands and toes of both feet were carbonized, presenting as branch-like dry necrosis (Figure 1). The left eye was severely burned and the cornea was perforated. A diagnosis was made of 99.5% TBSA burn wound, 5.5% deep second degree, 71% third degree and 23% fourth degree, and left eye burn with corneal perforation.

Fluid resuscitation, anti-infection therapy, mechanical ventilation, and maintenance of internal environmental stability were continued on admission to protect organ functions. The patient overcame the shock phase in stable condition. On the 3rd day after the injury, escharectomy of the 4 extremities and trunk was performed, involving 65% TBSA, and the wound was covered with nitrogen-preserved alloskin. As there was only 0.5% TBSA normal scalp available, we used the "microskin autografting and alloskin repeated grafting" method to repair the wound as soon as possible for the sake of preventing infection, which included using alloskin to cover and protect the wound temporarily, and repeated microskin grafting to sequentially close the wound. From the 5th day after the injury, the well preserved

Figure 1. Extraordinary severe burn involving 99.5% TBSA (**A**); muscular eversion and necrosis are seen in left upper limb like fish meat (**B**); fingers of left hand are carbonized and necrosed like dry branches (**C**).

scalp skin was dissected 5 times for microskin grafting of the right thigh, right upper arm, left thigh, anterior trunk and posterior trunk, closing about 10% TBSA wound. The areas that were not grafted with autoskin were still covered with alloskin. The interval between each skinning was about 10 days. Survival of the skin grafts was 80–90% (Figure 2). The residual wound was covered with small pieces of alloskin after debridement. The scalp skin was taken 6 times for stamp-like autoskin grafting to close the residual wound surfaces. The entire course of treatment lasted 120 days, during which 14 operations were done. Most of the wound was healed and repaired (Table 1).

As the 4 extremities of the patient sustained large areas of fourth degree burns with muscular necrosis and liquification, infection was likely to occur. In addition, myoglobin produced by decomposition of the necrosed muscle was liable to impair renal function and seriously threaten the patient's life. On the basis of careful intra-operative observation, those definitely necrosed tissues were resected without delay by incising the deep fascia and sarcolemma, and the exposed deep tissues were covered with alloskin. After multiple debridements, granulation tissue formed. The wound was closed with stamp-like autoskin grafts. As the muscle of the left upper arm was seriously necrosed, amputation was performed on the 10th day after the injury. As large amounts of muscle of both calves were necrosed, the tibia was exposed after clearing the necrosed tissue. As we were not able to cover it with flaps, holes were drilled on the exposed tibia to penetrate the cortex and reach the medulla for the sake of promoting granulation formation in the spaces created by the holes. When the formed granulation tissue covered the exposed tibia in about 4 months, stamp-like autoskin grafting was performed to close the wound of the right calf (Figure 3). Although the left tibia was covered by granulation

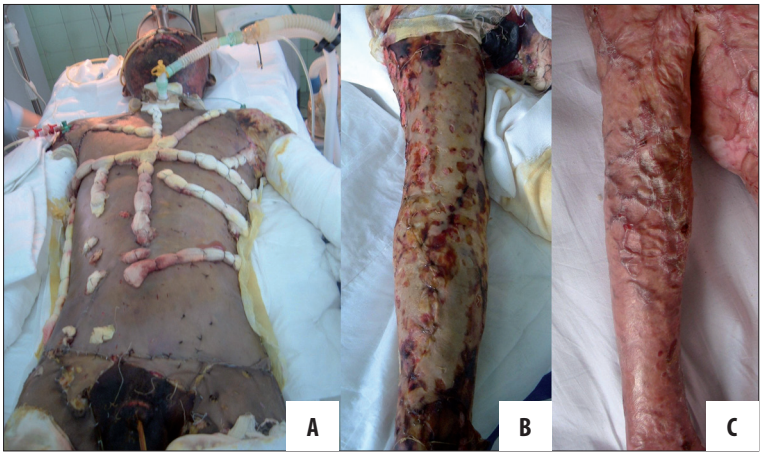

Figure 2. "Microskin autografting and alloskin repeated grafting" method to close the wound,the anterior trunk is cover with large pieces of alloskin to protect the wound (**A**); scalp microskin grafting of right upper limb was performed (**B**); mild scar proliferation is seen after healing of right upper limb (**C**).

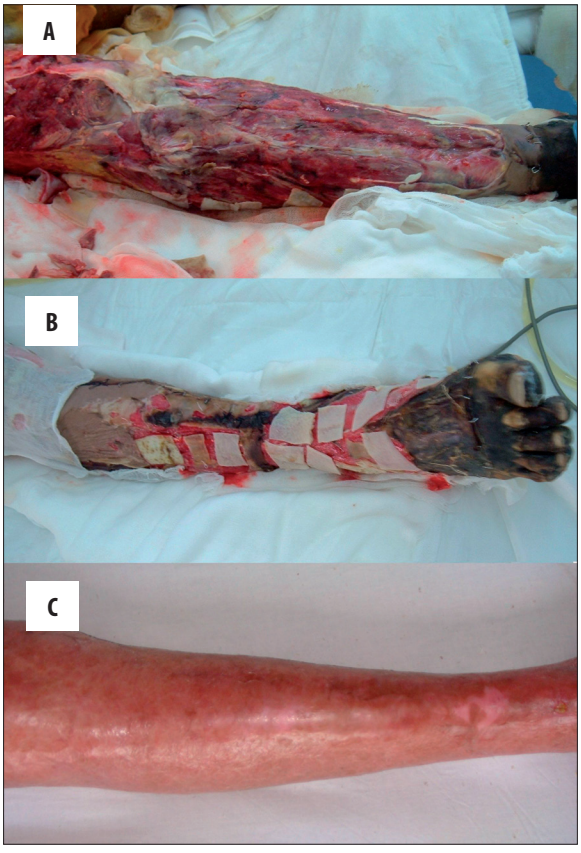

Figure 3. Muscular necrosis are seen in right calf (**A**); after repeated debridement and removal of necrosed muscular tissue, the tibia is exposed, which is covered with alloskin for protection (**B**); holes are drilled on the tibia, and the wound is closed with autoskin after granulation tissue formation (**C**).

tissue, bone marrow infection occurred in the long course of dressing changes. In addition, the left ankle completely lost its function, and the left foot was deformed due to scar contraction. The lower leg and 1/3 of the upper leg had to be amputated. The fingers and toes of the patient were also affected by deep burns, for which exposure therapy was used to keep the eschar dry. In about 3 months the eschar was lysed and fell off. Finger and toe amputations were performed after the necrosed margins became clear. Scar proliferation was apparent after wound healing. The scars were red and hard, and softened gradually over the course of 2 years. There was no significant dysfunction of the knee and elbow joints. Scars in the perineum and right armpit were adhered due to contraction, for which scar dissolution was performed, and acellular dermal matrix and auto scalp skin were grafted. The condition was ameliorated to some extent, but the patient was still handicapped by severe dysfunction, presenting as right finger defection and palm contraction, so that the patient lost the grasping, holding and lifting functions. The left foot was deformed due to contraction. The patient was developed a phobia of surgery due to repeated operations. In addition, further plastic surgery was also difficult for him because there was no supply of quality skin sources from his body.

In the course of treatment, though perceiving the magnitude of his disease, the patient held fast to hope of survival and showed gratitude to the medical staff. Currently, there is no obvious functional damage to the patient's heart, lung, liver, kidney and other organs. Particularly, our patient showed no sign altered thinking, language skills and audition between pre-injury and now. Unfortunately, due to amputation and scar contraction, our patient lost his ability to walk and to hold objects, among other survival skills. In addition, his left eye suffered severe vision impairment, and post-traumatic stress syndrome sometimes troubled him, such as depression and nightmares. However, with the support of his family, he preserved the will to live and face reality. He actively listened to the daily news, watched entertainment TV programs, and showed enthusiasm for life.

Discussion

This was a rare case of burn injury involving 99.5% of TBSA, including 23% TBAS fourth degree burn. The key to successful treatment of such patients depends on correct management and timely closure of the wound [3]. For repair of large burns, most developed Western countries use the Meek technique of skin expansion, or culture and transplantation of human auto epidermal cells [4,5]. Although the Meek technique has unique advantages of mild scar formation and good functional recovery, expansion of an area of skin is limited, usually to 6–9 times greater, which may be insufficient for patients with a scarcity of skin sources.

Table 1. Main procedures of wound repair.

Injury days	Operation	Autoskin closure (% TBSA)	Alloskin coverage (% TBSA)
3	Escharectomy of 4 extremities and trunk; alloskin coverage		65
5	Scalp skinning; microskin grafting of right thigh; debridement of left upper limb	9	56
10	Escharectomy of hips and alloskin coverage; debridement of both calves and alloskin coverage; amputation of left upper limb	9	55
15	Scalp skinning; microskin grafting of right upper limb; debridement of both calves and alloskin coverage	17	51
26	Scalp skinning; microskin grafting of left thigh	25	42
36	Scalp skinning; stamp skin grafting of 4 extremities	30	38
45	Scalp skinning; microskin grafting of anterior trunk	39	31
54	Scalp skinning; microskin grafting of back	51	20
65	Scalp skinning; stamp skin grafting of right calf	55	18
75	Scalp skinning; stamp skin grafting of back	59	15
88	Scalp skinning; microskin grafting of anterior trunk	63	12
93	Debridement of both feet; finger and toe amputation	63	12
102	Scalp skinning; stamp skin grafting of back	66	10
119	Scalp skinning; stamp skin grafting of trunk and residual 4 extremities	71	7

Epidermal cell culture is able to produce large areas of cell membranes *in vitro* in 3–4 weeks, but survival of the transplanted cell membranes is unstable. In addition, serious scar formation and high cost are problems that limit its routine use in developing countries [6]. Knowing that our patient was seriously short of endogenous skin sources, and that the above method was inapplicable to the patient, we made full use of the only remaining 0.5% TBSA normal scalp by means of the "microskin autografting and alloskin repeated grafting" method to repair the wound. The scalp served as a constant skin source at a mean interval of 10 days. Skin cutisection should not be too deep, otherwise healing of the donor area may be affected. Microskin grafting is a skin transplantation technique of Chinese origin, and contributes much to maintaining China's first-class success rate in curing patients with large burns [7,8]. In the present case, we used the 0.5%TBSA scalp to expand the skin by 10–20 times and close the 5–10% TBSA wound. Most of the wounds were closed by 5 episodes of microskin grafting, and the rest were treated by autoskin stamp grafts. Wounds that were not covered with autoskin were covered with alloskin to reduce exudation and evaporation, and to prevent infection. This not only provided favorable conditions for autoskin grafting, but also benefited improvement of the general condition and maintenance of organ functions of the patient. Rejection reaction developed 20–30 days after alloskin coverage, for which the alloskin was replaced in time to prevent the wound from exposing. Although the course of treatment of the patient was 4 months, no significant wound infection, disturbance of the internal environment and organ dysfunction occurred. This should be primarily attributed to timely and effective closure of the wound by use of autoskin and alloskin techniques.

Management of fourth degree burns is a huge clinical challenge [9]. For small fourth degree burn areas, flap repair is a routine solution [10], but in this patient, the fourth degree burn area was large and the other areas were also deeply burned, so flap repair was inapplicable. After repeated debridement, we used stamp-like autoskin grafts to close the wound after granulation tissue formation. The disadvantage was that it needed multiple operations performed over a long period of time.

Conlcusions

The quality of life of burn patients has long been a great concern both on the part of clinicians and society [11]. A survey of delegates at the 39th Annual Meeting of the British Burns Association showed that there are no conclusive criteria for abandonment of treatment of severe burn patients. Quality of life of burn patients is related not only to the severity of burn, but is also significantly related to educational backgrounds and family and social support. In China, treatment of severe burn patients is positive. For example, we have successfully saved many patients with greater than 80% TBSA burns, and most of them can take care of themselves and live a high-quality life. On admission of this rare case of severe burn, the doctors were fully aware of problems that the case might entail even though it was healed, such as deformity due to scar contraction, amputation, and loss of daily living abilities. The family had a strong desire to

save the patient. Although the patient experienced severe disability and dysfunction after healing, he is able to keep calm and face reality peacefully with the support, companionship and attention of his family.

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