

Original Article

Full-thickness degloved skin graft provide durable coverage of above-knee amputations with degloving injury of lower extremities

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Abstract: Background: Severe degloving injury of the lower extremities is uncommon but challenging. The study aimed to present our experience of skin grafts for the salvage of severe degloved above-knee amputation stump. Methods: From September 2007 to January 2014, five patients with severe degloving injury of lower extremities were treated with immediate full-thickness skin graft following a protocol of above-knee amputation. The full thickness skin grafts were harvested from the amputated limbs. Results: The patients ranged in age from 20 years to 52 years. Three of five patients recovered without any secondary intervention. Partial losses were found in two cases and one was treated with daily dressing, and another with secondary partial split-thickness skin grafts. Conclusions: Full-thickness degloved skin grafts represent a reliable and durable option to preserve sufficient limb length in above-knee amputations with degloving injury of lower extremities.

Keywords: Degloving injury, full-thickness degloved skin graft, above-knee amputation stump

Introduction

Degloving injuries of the lower extremities are characterized by avulsion of the skin and subcutaneous tissues from the underlying muscle and bone as a result of trauma [1]. Despite modern reconstructive procedures, amputation is sometimes required due to complex nerves, vessels, bones and skin associated injuries.

In the extensively degloved limb, there is a local lack of feasible skin, and this must be resolved when we try to preserve sufficient limb length for the function of walking with prosthesis. A number of reconstructive techniques may be used to provide viable skin coverage, including re-adaption of the flap, skin grafts, local or free flaps, revascularizations, etc [2-5]. So far, the concept of resurfacing the amputation stamps with a defatting full-thickness skin graft taken from an avulsed flap has been generally accepted [6]. In this study, we report our experience of skin grafted from an amputated limb to damaged stump at the same time as an above-knee amputation after degloving injury of lower

extremities with severe bone and soft-tissue damage.

Patients and methods

Patients

Five patients with severe degloving injuries of lower extremities were admitted to our hospital from September 2007 to January 2014. All had sustained a total degloving injury with severe lower extremities trauma in which an above-knee amputation was the presenting feature or was deemed necessary due to the severity of the injury. The mean age was 34 years (range, 20-52 years), with four males and one female. All patients were injured due to traffic accidents. The patients' details are summarized in **Table 1**.

Surgical techniques

Following initial resuscitation, the patients were taken to surgery. All patients had common-type avulsion injuries, extending distally up to proximally of lower extremities, with severe nerve, vessels and bones destruction. Amputation

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Table 1. Patients' details

Case	Age (years)	Gender	No. of surgeries until grafts healing	No. of complications related to skin graft	Outcomes related to skin graft	Mean of follow-up (month)
1	52	M	1	0	Completely healed	16
2	36	M	3	0	Partial graft loss and secondary grafting	15
3	34	M	1	0	Completely healed	11
4	20	M	1	0	Completely healed	8
5	28	F	1	0	Minimal graft loss and wound dressing up	10

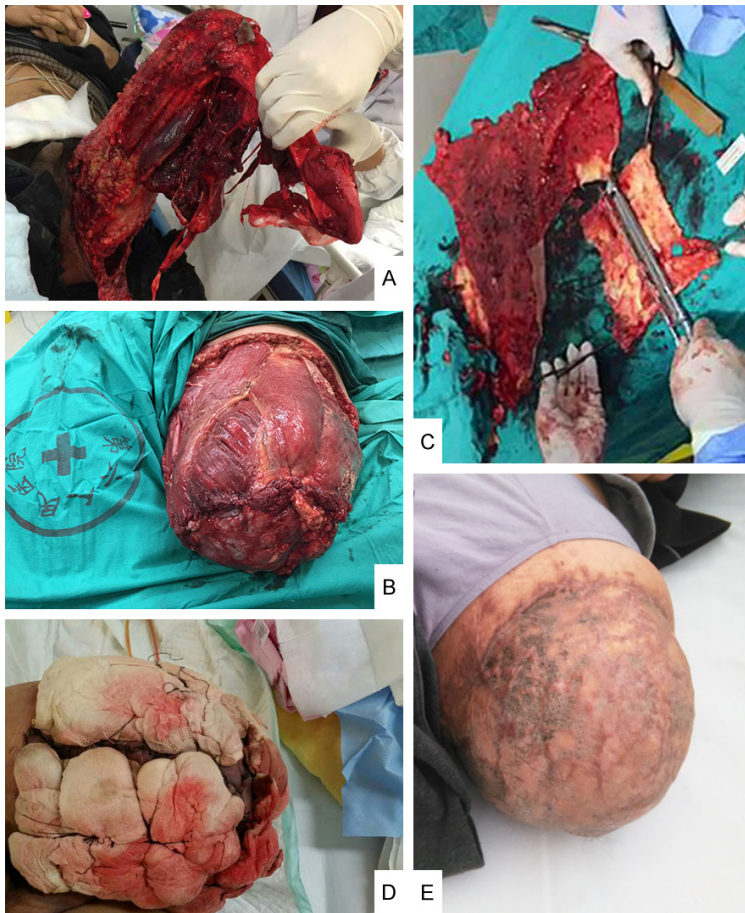


Figure 1. Case example shows successful stump coverage by full-thickness skin graft in a 34-year-old patient with an above-knee amputation, after degloving injury of lower extremities with severe bone and soft-tissue damage. A: A severe degloving injury of the lower extremities. B: An above-knee amputation after further debridement. C: The degloved skin is defatted with use of scalpels. D: The skin graft and bolster dressing. E: Well-healed stump about 11 months after injury.

was performed at an above-knee level. After excising non-visible distal structures and further debridement, the stump was covered with remaining muscles.

The degloved, tubular piece of skin was taken from the amputated limb and all subcutaneous tissues were removed by scissors sharp dissec-

tion just beneath deep dermis. Multiple stab wounds were made in the grafts to ensure draining of seroma and hematoma. After being secured to the wound edges and underlying recipient bed with multiple sutures, the stump was covered with a full-thickness defatted degloved skin graft at the same time. A positive pressure was applied on the skin grafts with a bolster dressing and compression to maintain good contact with the bed. All limbs were immobilized for seven to ten days postoperatively. Ten days after surgery, the dressings were changed every day and cleaned under sedation. If the grafts were not healing completely, it can be treated with daily dressing. In addition, secondary partial split-thickness skin grafting can be performed at two to three weeks postoperatively if necessary.

Results

Patients were followed for 12 months on average (range, 8-16 months). Mean hospitalization period was 21 days. Patients required an average of 1.4 operative procedures to achieve stump healing. Almost all of

the grafts were healed in three patients (**Figure 1**). In one patient, 15% of the area of the graft was lost. Secondary grafting was done with partial split-thickness skin grafts obtained from the contralateral thigh. There was minimal graft loss in one case, which was healed after daily dressing up to one month. All patients had minor stump problems and none had required

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a revision surgery. All the patients were able to walk adequately for their daily activities.

Discussion

Severe degloving injury of the lower extremities is uncommon but challenging. When amputation is inevitable, amputation level should be appropriately reconstructed rather than shortening the bone if there is insufficient soft tissue covering the stump [7]. In this study, full-thickness degloved skin grafts have been successfully performed in five cases for maintenance of adequate femoral length after critical traumatic soft tissue loss and to supply durable end-bearing coverage after a traumatic above-knee amputation. These skin grafts have proven to be sufficiently durable in these cases, in whom effective mobilization has been achieved.

Although at first sight, a primary reattachment of the avulsed skin flap back into its bed seems as the most functional and cosmetic treatment, it was reported with high rate of necrosis and infection [3]. Skin grafts were associated with poor cosmetic and functional outcomes, but they had good take and well drainage [8]. Initially, such injuries were treated following primary debridement with guillotine amputation, second look with fashioning of muscle flaps around the amputation stump and a number of delayed skin-grafting procedures [9]. Anderson et al reported an average of five operative procedures to achieve stump healing [10]. In this study, we propose an immediate defatting of the degloved skin from an amputated limb, thus creating a full-thickness skin graft which has been primarily used to cover the amputation stump. Moreover, immediate graft applications have shortened hospitalization time when an average of 1.4 operative procedures was achieved in our study.

To avoid the donor site problems, soft-tissue from the amputated part has sometime been used for the stump repair [11]. In our study, using full-thickness skin grafts from the amputated limb for reconstructive surgery well exemplified this kind of intervention. It would seem logical to use the amputated part as a donor site for our reconstructive process, which was predestinate to be discarded in usual course [12]. Compared with harvesting skin from the contralateral thigh, no loss was found at the donor site.

Flaps might be another choice for covering the amputation stump defects after degloving injury, especially when the traditional concerned that the skin grafts was too fragile to with stand the strain of prosthetic-limb wear was controversial [13]. Using filet flaps from the amputated limb to cover the ipsilateral extremity defects of amputation stump well fulfilled the need of weight-bearing [14]. Other flaps have also been reported for the reconstructive process. Shen et al used a retrograde sartorius myocutaneous pedicle flap to repair a lower-leg amputation stump [15]. Greig presented a case of multi-planar degloving injury to the lower limb that was covered with dermal regeneration template in association with a neurovascular fasciocutaneous pedicled flap salvaged from the non-viable lower leg [16]. The flaps seemed to provide sensate skin cover to weigh bearing areas of the stump reducing the chance of skin breakdown with prosthetic use. However, reconstructions with flaps were not always technically possible, presented a variable rate of success, and also extended the time of recovery and hospitalization. Many reports emphasized that even skin grafts were durable for prosthesis fitting [17]. Our policy of skin grafts was in keeping with the idea that the stump was covered with remaining muscles.

During amputation, length preservation was important for functional ambulation and weight bearing [11]. In these cases, the lesion of degloving injuries has extended to the proximal lower limb, even groin. Rather than shortening the bone to facilitate skin-to-skin closure, we usually tried to preserve residual limb length if at all possible [18]. It was obvious that patients with well reconstruction of the stump and adequate residual limb length would regain better functional recovery than with primary stump closure and fitting of prosthesis. In these 5 cases, full-thickness degloved skin had been converted from the amputation level to a more proximal area. Graft transportation for lower limb reconstruction was completed while no other donor-site was needed [19].

In our study, three of five patients recovered without any secondary intervention. Partial losses were found in two cases and one was treated with daily dressing, and another with secondary partial split-thickness skin grafts. It was an economical and a reliable treatment for avoid complicated flap applications [20]. In this

procedure, a valuable spare part for lower limb salvage was used immediately. Emergency repairing is considered to speed up rehabilitation and shorten hospitalization without donor-site morbidities occurred.

Conclusions

In summary, we present our usage of the full-thickness degloved skin graft from the amputated limb for salvage of above-knee amputation level in severe degloving injury patients. We have found it to be a durable, complication-free method for preservation of stump length, with acceptable outcomes.

Disclosure of conflict of interest

None.

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