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Our Experience With Free Microvascular Tissue Transfer in Burn Reconstruction

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ABSTRACT

OBJECTIVES: Free microvascular tissue transfer can provide excess tissue in 1 stage for extensive injuries when locoregional flap options cannot be performed. Free flaps are an important reconstructive option in burn reconstruction whenever neurovascular and skeletal structures are exposed. This sophisticated technique needs surgical expertise and an understanding of burn physiology. Here, we have shared our experiences in burn reconstruction with free flaps.

MATERIALS AND METHODS: Between 2017 and 2021, our center performed 26 free flap procedures in 20 burn patients. Fifteen flaps were performed in 12 patients at an early phase (first 21 days postinjury); 11 free flaps were performed in 8 patients for postburn contracture sequelae. Among these procedures, 60% were skin flaps (anterior lateral thigh, radial forearm, superficial circumflex iliac artery perforator flap, parascapular), 20% were musculocutaneous flaps (latissimus dorsi, vastus lateralis), 10% were fascia flaps (temporal fascia, serratus anterior), and 10% were pure muscle flaps (gracilis, latissimus dorsi).

RESULTS: Two free flaps for early-phase reconstruction and 1 free flap for postburn contracture release were lost. Reasons for flap loss were venous congestion in 2 cases, with arterial occlusion due to hematoma formation in 1 case. All patients with flap loss had high-voltage electric burns. Debridement of the necrotic flaps was delayed until demarcation formation settled and until subflap granulation formation started. Skin grafts were performed after debridement of these flaps. All other flaps survived, with no recurrence of contractures or defects encountered in these patients.

CONCLUSIONS: Although free flaps have changed the reconstructive ladder to a reconstructive elevator, performing these flaps have unique challenges in burn reconstruction, such as risk of thrombosis in those with electric burns, hemodynamic instabilities, and difficulties in patient positioning due to sedation. Meticulous care should be taken and the patient's general condition should be well evaluated before free flap surgery.

KEY WORDS: *Burn trauma, Free flap, Reconstructive microsurgery*

INTRODUCTION

Burn trauma is one of the most devastating injuries. Deep dermal burns result in skin defects that generally need tissue transfers for healing.[1] Although skin grafts are the widely accepted method for closing skin defects, the need for a skin flap may be inevitable. Local flaps, which are elevated around the defect, are considered risky in the acute term because of their close location to the trauma zone.[2] Free microvascular tissue transfer can provide excessive tissue in 1 stage for extensive defects when locoregional flap options are not possible. Thus, free flaps have been an important reconstructive option in burn reconstruction whenever neurovascular and skeletal structures are exposed.[3] This sophisticated technique needs surgical expertise and an understanding of burn physiology.

The success of flaps can be considered in 2 parts. First is the survival of the flap. Flap survival is related to the type of burn injury, timing of the surgery, general health condition of the patient, and the caliber and vascular status of the recipient's vessels. Although risks of complications

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ACKNOWLEDGEMENTS: The authors have not received any funding or grants in support of the presented research or for the preparation of this work and have no declarations of potential conflicts of interest.

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Burn Care and Prevention 2021/4: 174-178

with high-voltage electric burns are high, good results have been reported in the literature.[4] The second part is the aesthetic and functionality of the flap. Flap thickness, functional gain in the previously restricted areas, and donor site morbidity over time are the components of the second part. Here, we present our results with microvascular flaps in burn reconstruction in which we have analyzed these 2 parts.

MATERIALS AND METHODS

Between 2017 and 2021, 26 flap procedures were performed in 20 burn patients at the Baskent University Department of Plastic, Reconstructive, and Aesthetic Surgery. Of 26 flap procedures, 15 were performed in 12 patients in an early phase (first 21 days postinjury) and 11 were performed in a late phase of the injury (21 days to years postinjury) in 8 patients who had postburn contracture sequelae. Three patients had Marjolijn ulcers several years after burn injury. Flaps were divided into 3 groups: super-thin, thin, and bulky (Table 1). Free fascia flaps were considered in the super-thin flap group. Superficial circumflex iliac artery perforator (SCIP) flap and anterolateral thigh (ALT) flap were also considered within the super-thin flap group (Figure 1). Subfacial elevated SCIP and ALT flaps were considered as thin flaps according to body mass index of the patients (Figure 2). Musculocutaneous flaps, such as latissimus dorsi, gracilis, and vastus lateralis, were included in the bulky flap group (Figure 3).

RESULTS

Among the 26 flap procedures, 15.4% were super-thin flaps, 38.5% were thin flaps, and 42.3% were bulky flaps

FIGURE 1. Super-Thin Superficial Circumflex Iliac Artery Perforator Flap to Close an Electric Burn-Related Defect at Foot Dorsum

A very nice contour was achieved in the late postoperative term.

TABLE 1. Distribution of Patients According to Free Flap Thickness

Super-Thin Flaps (N = 4)	Thin Flaps (N =10)	Bulky Flaps (N = 11)
Serratus anterior fascia flap (n = 2)	Radial forearm flap (n =3)	Parascapular flap (n = 1)
Temporal superficial artery flap (n = 1)	Subfascial elevated ALT flap (n = 6)	Gracilis flap (n = 1)
Super-thin elevated SCIP flap (n = 1)	SCIP flap (n = 1)	Latissimus dorsi flap (n = 5)
		Vastus lateralis flap (n = 1)
		Subfascial ALT flap (n = 3)

Abbreviations: ALT, anterolateral thigh; SCIP, superficial circumflex iliac artery perforator

FIGURE 2. Radial Forearm Flap Elevated and Adapted to Foot Dorsum Defect From Radiant Heater Burn

Satisfactory results were achieved in the late postoperative term both in the recipient and donor sites.

(Table 1). Sixty percent of the flaps were skin flaps (anterior lateral thigh, radial forearm, SCIP, parascapular), 20% were musculocutaneous flaps (latissimus dorsi, vastus lateralis), 10% were fascia flaps (temporal fascia, serratus anterior), and 10% were pure muscle flaps (gracilis, latissimus dorsi). Two free flaps for early-phase reconstruction and 1 free flap for postburn contracture release were lost. Reasons for flap loss were venous congestion in 2 cases and arterial occlusion due to hematoma formation in 1 case. All patients with flap loss had high-voltage electric burns. Debridement procedures for the necrotic flaps were delayed until demarcation formation had settled and subflap granulation formation had started. Skin grafts were performed after debridement of these flaps. All other flaps survived, with no recurrence of contractures or defects encountered in any of these patients.

DISCUSSION

With recent developments in reconstructive microsurgery, free microvascular tissue transfers are now widely used in burn reconstruction.[5] Surgeons can transfer undamaged tissue to cover large areas of composite defects in one stage.

FIGURE 3. Gracilis Muscle Free Flap Procured for Reconstruction of a Squamous Cell Carcinoma Defect Due to Marjolin Ulcer After Burn History

The bulk of the flap gradually decreased over 2 years.

Thus, free flaps are superiorly placed in the reconstructive ladder versus alternatives such as expanded local flaps, expanded perforator flaps, and local flaps.[6] However, less than 2% of burn injuries undergo free flap procedures.[7] The timing of the surgery and the type of injury are dominantly linked with complications.

In our series, all of the complications were because of electric burn injury history. Most complications occurred in the first 21 days of trauma. Baumeister and colleagues similarly reported that 26% of the complications occurred between day 5 and day 21.[8] They reported that this complication rate was because of increased risk of infection and thrombosis. Electric burn injury has been linked with increased rate of flap loss in the literature. Sauerbier and colleagues reported higher failure rate in patients with high-voltage electric burns.[9] They concluded that this was because of increased risk of intimal damage, thrombosis, and unstable major arterial circulation. Recipient vessel selection beyond the trauma zone is another important step for preventing vascular complications. Koul and colleagues suggested a well-pulsating artery should be inspected prior to anastomosis.[10] In an experimental model with rabbit limbs, 3 cm beyond the injury site was found to be reliable for anastomosis.[11] We routinely perform angiography before free flap surgery to decide the condition of the recipient's vessels. We also try to procure longer pedicles than estimated in case of need to go more proximal. Thus, ALT flap or radial forearm flap are preferred flaps because of longer pedicle length. We have corrected postburn contractures in the late phase of the injury.[12]

Flap thickness was not found to be related with complications in our series. At our center, we prefer super-thin flaps such as fascial flaps for the extremities to prevent bulk-related restrictions. A requirement for a skin graft has been the most discussed drawback of fascial flaps.[13] Super-thin elevations of SCIP flap or ALT flap are other alternatives to fascial flaps for extremity reconstruction.[14] However, the body mass index of the patient should be considered to achieve desired thickness.[15] Defect sizes are also a major decisive factor for selection of other flaps. We use parascapular and gracilis flaps for moderate defects. With regard to bulky flaps, we use these for cases of infection or to cover massive defects. Latissimus dorsi muscle flaps can provide excessive well-vascularized tissue for scalp or extremity defects.[16]

CONCLUSIONS

Although free flaps have changed the reconstructive ladder to a reconstructive elevator, performing these flap procedures can present unique challenges in burn reconstruction such as risk of thrombosis for electric burns, hemodynamic instabilities, and difficulties in patient positioning due to sedation. Meticulous care should be taken and the patient's general condition should be well evaluated before free flap surgery.

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