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CLINICAL ARTICLE

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Nose resurfacing with free fasciocutaneous flaps in burns patients

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Background: Nasal reconstruction after burn injury can be challenging due to limited availability of local flaps. We present our experience of free flap reconstruction for full-thickness nasal defect after severe facial burn injury.

Methods: Between August 1998 and September 2015, six patients underwent nasal reconstruction with seven free flaps after burn injury. Among them, flame burn occurred in two patients, chemical burn in two, explosive burn in one, and contact thermal burn in one patient. The percentage of total body surface area ranged from 4% to 48%, and the face and forehead were involved in all patients. Their clinical and photographic records were retrospectively reviewed to evaluate the aesthetic results.

Results: Four ulnar forearm flaps, one radial forearm flap, one anterolateral thigh flap, and one medial sural artery perforator flap were used for nasal reconstruction. The nasal framework was constructed simultaneously using costal cartilage or conchal cartilage. The facial artery and vein were typically used as recipient vessels. One case each of partial necrosis and infection were noted during the average follow-up of 59 months (range, 16–126 months). Patients had satisfactory aesthetic and functional outcomes after 4.5 times (range, 2–7 times) refinement operation.

Conclusions: Free flap is an applicable alternative to restore nasal skin envelope, with rebuilding the nasal framework performed in the same stage after severe facial burn injury. Through thoughtful planning and sufficient refinement, satisfactory aesthetic, and functional results are achievable.

1 | INTRODUCTION

The nose is the central pillar of the face and the most difficult facial component to reconstruct (Taghinia & Pribaz, 2008) owing to its complex three-dimensional anatomy and breathing function. In facial burns, it adds a further complexity by injuring the potentially useful adjacent tissues, which may themselves require reconstruction (Prousskaia, El-Muttardi, Philp, Dziewulski, & Shelley, 2015). In addition, although forehead flap provides the best color and texture match of the nasal tissues (De Lorenzi, van der Hulst, & Boeckx, 2001), the tight adherent forehead scar in burn victims also precludes its use as an ideal donor site (Sinha, Scott, & Watson, 2008). In this situation, a free flap harvested from a donor site free of burn injury offers a viable alternative for nasal reconstruction. However, few reports demonstrating its application in burned nose are available. Most of them were only case reports or utilizing free flaps for reconstruction the face, but not focusing on nose (De Lorenzi et al., 2001; Iglesias, Butrón, Chávez-Muñoz, Ramos-Sánchez, & Barajas-Olivas, 2008; Prousskaia et al., 2015; Rose, 2015; Winslow, Cook, Burke, & Wax, 2003). Prousskaia et al. presented not only six free flaps in burned nose reconstruction but also included other reconstruction methods in their series (Prousskaia et al., 2015). Lorenzi et al. demonstrated two free flaps for burned nose reconstruction but without providing the details (De Lorenzi et al., 2001). In this report, we presented our experience with free flap

resurfacing for full-thickness nasal defect after severe facial burn injury. The indications, flap choice and their comparison, intraoperative management, and postoperative outcomes of this procedure are discussed.

2 | PATIENTS AND MATERIALS

This retrospective report was performed at Chang Gung Memorial Hospital after obtaining approval from the Institutional Review Board.

Between August 1998 and September 2015, six patients underwent nasal reconstruction with seven free flaps for burned nose. The demographics and characteristics of all patients are shown in Table 1. From six patients who underwent free flaps resurfacing for burned nose, two were males and four were females, and the average age was 29.3 years (range, 7–50 years). According to the mechanism of the burn injury, two patients had flame burns, two had chemical burns, one had explosive burn, and one patient had explosive burn. The % total body surface area (TBSA) ranged from 4% to 48%, and the face and forehead were involved in all patients. One patient underwent free flap coverage for the face and nose in the acute stage (6 days after burn injury) due to eyeball and zygoma bone exposure. In the remaining cases, the average duration between the initial burn injury and nose reconstruction was 10 years (range, 3–18 years). Our choice of flap used for resurfacing was determined by the availability of unburned area. Four ulnar forearm flaps, one radial forearm flap, one anterolateral thigh (ALT) flap, and one medial sural artery perforator (MSAP) flap were used for nasal resurfacing.

3 | SURGICAL TECHNIQUE

After excising the contracture burn scars over the nose, a full-thickness defect was found. The nasal framework was constructed with autologous costal cartilage in five cases and conchal cartilage in one case. Spreader graft, columellar strut, and bilateral alar rim grafts were usually built. Based on the nasal subunit principle, the defect was extended to meet the subunit principle and often resulted in subtotal or total nasal defect. The size and shape of the defect were copied to a foil template and the pattern was centered over the auscultated axial vessels or perforators at the donor site and positioned for optimal vascularity (Rose, 2015). The peripheral flap margin was designed based on the template, or extended to obtain a fusiform shape for better donor site closure. Facial artery and vein were typically used as recipient vessels. A subcutaneous tunnel was made from the defect to mandible angle area for path of the pedicle, which was usually approximately 10 to 12 cm in length. After revascularization, the flap was inseted and the wound was closed loosely with several open drains left. The donor site of the ALT flaps could be closed primarily and the others were resurfaced with a skin graft.

We usually performed the refinement procedure such as debulkiness of the flap, creating the alar grooves or any small adjustment or modifications with the interval of two to three months between each surgery, to obtain a more stable and reliable flap circulation.

TABLE 1 Demographics, characteristics and outcomes of patients Duration: Duration from initial burn injury to nasal reconstruction with free flaps

No	Sex	Age	Burn	TBSA (%)	Duration	Free flap	Defect	Framework (cartilage)	Recipient Vessel	Flap size (cm^2)	Refinement	NOSE	ROE	Follow-up (months)	Complication
1	F	21	Flame	–	18 years	UFF × 2	Skin	Costal	FA	7 × 7.5	4	5	17	65	None
2	F	23	Chemical	–	16 years	UFF	Skin	Costal	FA	7 × 7	5	2	20	67	None
3	F	31	Chemical	10	5 years	UFF	Skin + lining	Costal	FA	5 × 7	7	2	19	50	None
4	M	37	Flame	40	3 years	ALT	Skin	Costal	FA	7 × 7	2	5	18	30	None
5	F	32	Explosive	48	8 years	MSAP	Skin	Costal	FA	7 × 8	3	3	20	16	None
6	M	7	Contact thermal	4	6 days	RFF	Skin+face	Conchal	STA	5 × 12	6	4	17	126	None

ALT, anterolateral thigh flap; FA, facial artery; MSAP, medial sural artery perforator flap; NOSE, nasal obstruction symptoms evaluation score; RFF, radial forearm flap; STA, superficial temporal artery; ROE, rhinoplasty outcome evaluation score; UFF, ulnar forearm flap.

Care must be taken to avoid too aggressive debulking or any refinement procedure, and to preserve the blood supply at all stage.

4 | OUTCOME EVALUATION

A review of photographic documentation was used to evaluate the aesthetic results. Besides, we performed the functional assessment with NOSE (Nasal Obstruction Symptoms Evaluation) questionnaire (Saleh, Younes, & Friedman, 2012) and subjective scale assessment with ROE (Rhinoplasty Outcome Evaluation) score (Saleh et al., 2012) by telephone interview. Average total scores for both scores were calculated.

5 | RESULTS

The nasal framework was constructed simultaneously with autologous costal cartilage in five cases and conchal cartilage in one case. The flap size ranged from 5 × 7 cm to 7 × 8 cm; the flap was used for restoring nasal skin envelope in four patients and for partial nasal lining in combination with skin cover in one patient. Facial artery and vein were typically used as recipient vessels. For the patient in whom the free flap was used for coverage of both the nose and face, the flap size was 5 × 12 cm and the recipient vessel was the superficial temporal artery. The average ischemia time was 48 minutes (range, 38–60 minutes).

No flaps encountered circulation problems and there was no complications such as hematoma, wound infection, or flap necrosis in the early stage. Infection occurred in one case 3 months postoperatively and necessitated the costal cartilage removal and replacement with an alloplastic implant one year later. Partial necrosis of another flap was noted after performing debulking procedure 1.5 months after the initial reconstruction, and the flap was discarded and replaced by another free flap.

For functional assessment, the average total NOSE score was 3.5 (range, 2–5). No patient had obvious respiratory problems even during exercising, which demonstrated good functional results. Since the perfect aesthetic result was impaired by burn injury, the functional outcome is especially important to assess in this subset of patients. With respect to subjective satisfactory outcome, the average total ROE score was 18.5 (range, 17–20), which indicated acceptable aesthetic results after an average of 4.5 times (range, 2–7 times) of refinement operations during 59 months (range, 16–126 months) of follow-up.

6 | CASE REPORT

6.1 | Case 1

A 32-year-old woman who had a nasal deformity after a burn injury (Figure 1A,B). Nasal reconstruction was performed 8 years after initial injury. A total nasal defect was found after the scar tissue removal using the principles of the nasal subunits. Right MSAP flap, 7 cm × 8 cm, was used to restore the skin envelope (Figure 2A,B). The nasal framework was reconstructed using rib cartilage. Spreader graft, columellar strut, and bilateral alar rim grafts were built (Figure 2C,D). Three refinement surgeries were performed to improve the final nasal profile and aesthetic outcome (Figure 3A,B).

6.2 | Case 2

A 37-year-old man suffered from flame burn injury over face and resulted in nasal deformity (Figure 4A,B). Nasal reconstruction was performed 3 years after burn injury. Left ALT flap, 7 cm × 7 cm, was utilized for reconstruction of total nasal defect, with nasal framework built with rib cartilage simultaneously. After two refinement surgeries (Figure 5A,B), satisfactory outcome was achieved 30 months postoperatively (Figure 6A,B).

FIGURE 1 (A, B) Postburn nasal deformity, case 1

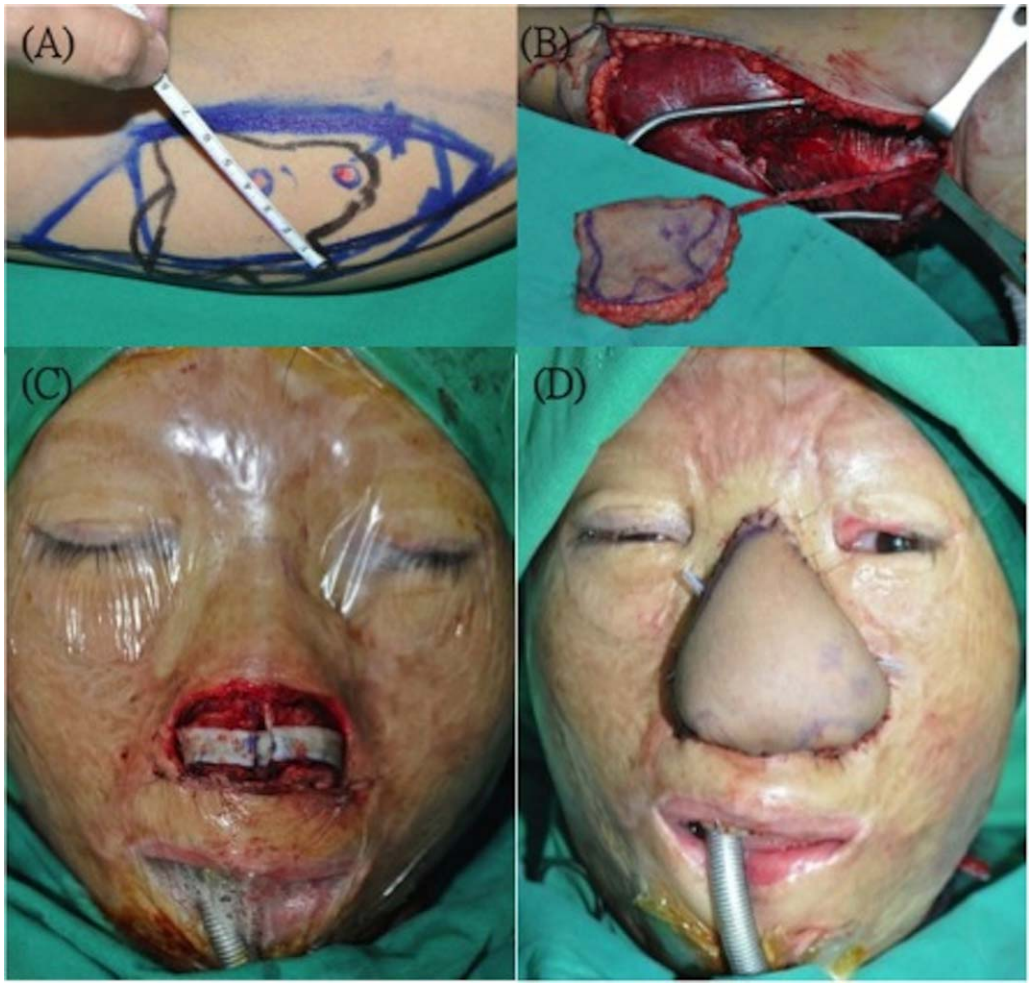

FIGURE 2 (A) Design of medial sural artery perforator flap (B) Harvesting of medial sural artery perforator flap (C) The nasal framework was reconstructed using rib cartilage. Spreader graft, columellar strut, and bilateral alar rim grafts were built (D) Immediate post-op photo

FIGURE 3 (A, B) 11 months postoperative outcomes of the medial sural artery perforator flap for burned nose reconstruction

FIGURE 4 (A, B) Postburn nasal deformity, case 2

7 | DISCUSSION

Burned nose reconstruction is usually challenging (Winslow et al., 2003; Ibrahim et al., 2015). Although burn scars have been used as flaps in previous studies (Barret, Herndon, & McCauley, 2002; Chen et al., 2008; King, Nikkhah, Martin, Gilbert, & Dheansa, 2014; Menick, 2002; Prousskaia et al., 2015; Taylor, Carty, Driscoll, Lewis, & Donelan, 2009), their safety and reliability still remains questionable due to its altered blood flow and lack of normal microcirculation (Barret et al., 2002). Thus, the free flap with robust blood supply and small chance of recurrent scar retraction may provide a viable reconstructive alternative for more predictable and efficacious results in this extremely challenging group (Winslow et al., 2003; Ibrahim et al., 2015). This report is the first of this kind to present all the cases of burned nose resurfacing with free flaps. Some previous related literature were only case reports or utilizing free flaps for reconstruction the face, not only for nose. In nasal reconstruction, we have to consider the aesthetic and functional results simultaneously. The ideal nasal contour comes from not only exquisite skin envelope but also the steady underling platform and framework, which was different from resurfacing the other facial units due to its three-dimensional structure. In this report, we focused and concentrated on the indication, flap choice and

FIGURE 5 (A) Immediate postoperative outcomes of the anterolateral thigh flap reconstruction. (B) Refinement procedures to define the lateral lines of the dorsum and bilateral alar grooves

FIGURE 6 (A, B) 30 months postoperative outcomes of the anterolateral thigh flap for burned nose reconstruction

their comparison, intraoperative management, and postoperative outcomes of free flaps in burned nose resurfacing, and discussed about what's the same and difference between this procedure and traditional microsurgery or nasal reconstruction. This is the first report dealing with the comprehensive concepts of free flaps in burned nose reconstruction.

Different types of free flaps have been used for nasal resurfacing, each one with its own advantages and disadvantages (Antunes & Chalian, 2011; Benmeir et al., 1991; Iglesias et al., 2008; Prousskaia et al., 2015). These flaps were usually fasciocutaneous flap, thin in both the skin and the soft tissue, creating the contour around the nasal framework and providing adequate lining without obstructing the nasal airway (Antunes & Chalian, 2011). Second, they usually had a long pedicle to achieve recipient vessels (Antunes & Chalian, 2011). The radial forearm flap was traditionally considered the most optimal option for nasal reconstruction, both for skin envelope and especially for restoring the nasal lining (Burget & Walton, 2007; Kobayashi, Yoza, Sakai, & Ohmori, 1995; Menick & Salibian, 2011; Walton, Burget, & Beahm, 2005). Other flaps included latissimus dorsi flap, thoracodorsal artery perforator flap, dorsalis pedis flap, lateral arm flap, first dorsal metacarpal flap, ALT flap, and arterialized venous flap (Antunes & Chalian, 2011; Benmeir et al., 1991; Iglesias et al., 2008; Prousskaia et al., 2015). However, in secondary burned nose reconstructions, flap choice is not only dependent on recipient site characteristics, but also on donor site availability.

In our series, the forearm flap was mostly used for nasal resurfacing, which was consistent with previous reports (Burget & Walton, 2007; Kobayashi et al., 1995; Menick & Salibian, 2011; Walton et al., 2005). However, we preferred ulnar forearm flap due to its superior donor site cosmesis (Hsiao et al., 2016). Additionally, we found that MSAP flap can be another suitable choice, with its similar characteristics to the forearm flap, but less donor site morbidity (Ives & Mathur, 2015; Kao, Chang, Wei, & Cheng, 2009; Nugent, Endersby, Kennedy, & Burns, 2015; Toyserkani & Sørensen, 2015; Xie & Chai, 2012). With careful planning and meticulous dissection, we tend to gradually avoid the forearm flap and use this flap as a free flap in nose resurfacing. Again, flap choice still depends on donor site availability. Therefore, one patient in this report utilized ALT flap for nasal resurfacing due to burn scars over both forearms and lower legs.

The recipient vessels used in microvascular reconstruction for nasal defects are usually the facial artery and vein (Antunes & Chalian, 2011). In cases of burns, although the overlying tight skin is often hypertrophic and thick, the recipient vessels can still be found in the subcutaneous or muscle layers (De Lorenzi et al., 2001). It is essential to dissect all scars and contraction bands above the microvascular anastomoses and to make a loose tunnel for pedicle.

Other principles did not differ from those of general microsurgery. The reported total survival rate of free flaps ranges from 78% to 94% in burn patients (De Lorenzi et al., 2001). In our series, all flaps survived without early complications. We consider that with adequate removal of scar tissue, meticulous planning and dissection, the free flap in burn reconstruction could achieve high success rates, comparable with those of healthy tissue.

The most important aspect of nasal microvascular reconstruction is the separate analysis of each component of the nasal defect: skin, osteocartilaginous framework, and lining (Antunes & Chalian, 2011). Options for nasal lining reconstruction include skin grafting, mucosal grafting, local flap, turn-over flap, pedicled flap such as reversed facial artery musculomucosal flap, folded forehead flap, or free flap (Winslow et al., 2003). Fortunately, the linings in this group of patients are usually intact at the nasal vault but missing at the columella and alar levels. We utilized turnover flaps from the scars on alar and columella to supply missing alar linings and columella in most cases. Only one patient required a single free flap for restoring both the external skin envelope and partial lining defect.

Skeletal support provides the major aesthetic and functional needs of the nasal reconstruction and it is crucial for soft tissue dimensions to

be maintained (Taghinia & Pribaz, 2008). Generally, the original cartilage framework is preserved, but collapsed or distorted in burned nose. The main purpose of framework reconstruction is to reinforce the original distorted cartilage, especially bilateral alar rim grafts. In certain cases, onlay dorsal graft is used to improve the aesthetic result. Since the septal cartilage is usually limited in quantity and the conchal cartilage is sometimes destroyed in burn injury, autologous costal cartilage serves as a sufficient source for framework reconstruction. Although some surgeons preferred to put cartilage in a short-time secondary procedure, we still prefer to establish the cartilage framework simultaneously when free flap is inset. Free flap starts to shrink right after harvesting from the donor site, so a sturdy cartilage framework is crucial to resist uncontrolled free flap shrinkage and facilitate to shape free flap into ideal nasal contour.

Despite Gilles and Millard's admonition to employ "like" tissue (Menick & Salibian, 2011), it is difficult to achieve this principle in burns reconstruction. The appropriate nasal subunits should be covered to minimize the patch effect (Hafezi, Pegahmehr, & Nouhi, 2002) and the adjacent facial aesthetic units should also be taken into consideration. Individualized planning and reconstruction is especially crucial since every patient had different degree of severity, location and availability of donor site of burn injury. We found that compared to the free flap on an unburned or unscarred face, the color mismatch or patch-like looking in burned nose resurfacing may be not so distinct or abrupt due to the surrounding burned scar or previous skin graft reconstruction. Of course, some refinement procedures are mandatory to achieve optimal results.

Perfect microvascular restoration of the nasal defects is practically impossible and is always staged. The key aspect of the contouring procedure is to approach the central facial features through incisions that will lie in the deepest facial shadow, as the lateral lines of nasal dorsum, the border of the tip subunit, the alar grooves, and the nasolabial grooves (Burget & Walton, 2007). We usually performed the contouring procedure at least 2–3 months after the initial reconstruction, to obtain a more stable and reliable flap circulation. However, care must be taken to avoid too aggressive debulking or any refinement procedure, and to preserve the blood supply at all stage. In our series, patients could get satisfactory results after an average of 4.5 times of refinements, even in relatively thick flaps, like ALT flap.

8 | CONCLUSIONS

In terms of limited local tissues availability for nasal reconstruction after severe facial burn injury, free flap serves as an applicable choice to restore skin envelope, and the nasal framework rebuilding could be performed in the same stage. Through thoughtful planning and sufficient refinement, satisfactory aesthetic and functional results are achievable.

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