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Application of different expanded forehead flaps for cervicofacial defect reconstruction.

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Abstract

Objective: To evaluate the clinical efficacy and safety of different expanded forehead flaps in the cerviofacial reconstruction, aiming to identify an optimal technique.
Methods: A total of 70 patients who suffered from scars contracture, nevus, vascular anomalies (hemangioma and capillary malformation), nasal defects and facial cleft admitted to our hospital between June 2014 and December 2016 were recruited. According to the location of these deformities and lessons, four types of expanded forehead flap were adopted.
Results: In total, 70 patients accepted expanded forehead flaps for faciocervical reconstruction. Type I flap was practiced on 29 patients (12 male, 17 female), type II flap for 23 patients (14 male, 9 female), type III flap for 10 male patients and type IV flap for 8 patients (6 male and 2 female). All the donor sites of types I, II and IV flap were closed primarily, and no incision was disrupted during the staged operations; the temporal donor sites of type III flap would be repaired by the pedicles at the third stage.
Conclusion: The expanded forehead flaps can be flexibly applied in reconstruction of different faciocervical units for not only its well color and texture matched, but also its reliability of blood supply and relatively uncomplicated technique.

Keywords: Forehead flap, Reconstruction, Cerviofacial defect, Clinical efficacy.

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Introduction

Owing to face and neck contain complex tissues and require a high demand for the appearance and function after reconstruction, different faciocervical defects caused by various causes are still distressing problems for plastic and reconstructive surgeons. Skin grafts is a simple and feasible method, but should generally be avoided as definitive repair because they often result in secondary contracture and produce a patchy appearance arising from their poor color matching with facial skin. Local non-expanded flaps such as cervicofacial rotation advancement flaps result with long back-cutting incisions [1], thus it is not suitable for those patients, especially the Asians, of high demand for appearance. Free flaps often act as workhorse flaps in the reconstruction for acute wounds and defects after tumors resection. Apart from free flap failure [2], their bulkiness coupled with bad-matched color and texture is the main reasons that patient's eager for second aesthetically reconstructive operations.

The forehead has a well matched color and texture to the other regions of face and neck, and has been generally recognized as the excellent donor site for nasal reconstruction [3]. Due to it has a reliable blood supply from different kinds of arteries, various types of forehead flap can be elevated for reconstruction of other different facial units. For aesthetically treatment of large faciocervical defect/lesion, the forehead flap can get well improvement on flap size as well as its thickness with the assistance of tissue expansion technology.

Until now, it has a certain amount of literatures published about the clinical applications of forehead flaps. Most of them were presented as non-expanded flaps and mainly focus on reconstruction of a single region of face and neck, such as the nose and periocular zone [4-6]. Even the expanded forehead flaps were largely shown as case report/series for reconstruction of a particular region [7]. Less experience of systematic evaluation was focused on different types of the expanded forehead flap in faciocervical reconstruction. Herein, aiming at testing whether all the unit/multi-units of face and neck could be aesthetically reconstructed by expanded forehead flaps and then proposing a strategy of flap selection, we reviewed the applications of expanded forehead flaps for cerviofacial rehabilitation in our hospital.

Materials and Methods

During June 2014 and December 2016, we applied expanded forehead flap technique to 70 patients who suffered from scars contracture, nevus, vascular anomalies (hemangioma and capillary malformation), nasal defects and facial cleft. Among patients with scars, nevus and vascular anomalies, split-

thickness skin graft was performed previously and then were drawn into scars group for easy algorithm. Pre- and post-operative images and surgical procedures and recovery conditions were collected for flap choosing, complications and reconstructive outcomes.

For better guidance of defects classification, the face and neck can be artificially divided into six units: the forehead unit, the orbital unit, the nose unit, the cheek unit, the perioral unit (lips and chin) and the neck unit. The periorbital area includes the upper and lower lids as well as the lateral and medial canthi subunits, and the cheek can also be divided into four subunits containing Medial (M), Zygomatic (Z), Lateral (L) and Buccal (B) subunit.

According to the location of these deformities and lessons, four types of expanded forehead flap were adopted. This classification of flaps was based on the blood supply of forehead that is mainly supported by three vessels: the Superficial Temporal Arteries (STAs), Supratrochlear Arteries (STrAs) and the Supraorbital Arteries (SOAs). Type I was pre-expanded local flap; Type II was axial-pattern pedicled expanded forehead flap, also described as expanded paramedian forehead flap, on the basis of the unilateral STrA; Type III was bilateral-pedicled expanded forehead flap, blooded by the frontal branch of the STA on each side of temporal zone; Type IV was unilateral-pedicled expanded forehead flap based on the superficial temporal vessels.

Results

Baseline data

A total of 70 patients received expanded forehead flaps for faciocervical reconstruction. Type Iflap was practiced on 29 patients (12 male, 17 female); type II flap for 23 (14 male, 9 female); type III flap for 10 (all male) and type IV flap for 8 (6 male and 2 female). The causes and locations of defects for each type flap were illustrated.

Surgical procedures

Type I flap was advanced for repairing defect of partial forehead unit, subunits of the periorbital unit or partially involved the two adjacent units. Type II was used to resurface the nose, the lower eyelid and medial canthi subunit, upper cheek unit (mainly including M and Z subunits) and partially involved these adjacent units. Type III was applied for reconstruction of lower face (perioral unit) and anterior neck. TypeIV was employed to reconstruct ipsilaterally part of the middle face including the lower eyelid and partial cheek.

Postoperative complications

Among postoperative complications, 4 cases were infected during flap expansion. Except 1 case failed with expander removal, the other three were rescued by irrigation, and saline infilling was continued and treatment plan was less influenced. Port leakage was detected in 2 cases, and salvage method was that the buried port was exteriorized with the connective tube occluded by a clip. One expander rupture was observed at the end of expansion. For the expanded flap was large enough, the flap transfer operation was done to the patient, who showed a well aesthetic outcome at last. Vein congestion occurred in 3 cases at the distal 1-2 cm of flaps (1 type I flap, 1 typeII flap and 1 type IV flap), and were treated with bloodletting through puncturing on the flaps with a needle and topical application of heparin. All donor sites of types I, II and IV flap were sutured, and no incision was disrupted during the staged operation. The temporal donor sites of type III flap would be repaired by the pedicles at the third stage. One patient showed unilateral brown ptosis with type I flap. Two patients without preoperative ectropion presented with a slight eyelid and eyeball separation after accepting type II or IV flap.

Discussion

In faciocervical reconstruction, the match of color and texture remains the main consideration aiming at aesthetics, and therefore the neighboring normal soft tissues should be taken as primary donor sites8. Technical simplicity and reliability is another considered element. Unlike the long-time operation and relatively high risk of necrosis of free flap after transfer, one flap of adequate blood supply and easily harvest and transfer is to be valued. The forehead flap can meet these conditions [8-10]. Facial defects resulted from different etiologies are often massive, and forehead flap purely harvest from one-stage operation cannot obtain sufficient skin size. So expansion technology can acts as the important role of increasing the skin surface area, as well as succeed in primarily donor-site closed. In addition, expansion can play a role in reducing the thickness of soft tissue to permit facial expression and maintain facial contours. Based on the exposition above, the forehead flap combined with tissue expansion technology is highlighted for facial reconstruction both aesthetically and functionally.

Normal forehead skin after expansion should be considered as the primary choice for the rehabilitation of forehead defects with the advancement and rotation technology as the frequently-used method. Expander can be placed subcutaneously or under the frontalis. If the defect/lesion is less than 1/4 total forehead, selected expander can be inserted subcutaneously without damage to frontalis muscle and facial nerve branch. Otherwise, when encountering a huge defect/lesion covering hemi-forehead or even more, a pocket created under muscular layer may be safer because of strict requirement of sufficient blood and a certain thickness of tissue for flap survival during both expander expanding(mostly over-expanding) period and the flap transfer stage. Furthermore, defect/lesion larger than 1/4 forehead often requires a serial expansion for better outcome [11]. Partial forehead defect/deformity with adjacent parts such as the upper eyelid, the lateral and medial canthi subunits can also be reconstructed with expanded local forehead flap. Cutaneous flap without muscle is more suitable for the periorbital unit because of proper thickness. Flap thinning can be operated to the part of the full-thickness expanded forehead flap that transferred to the

periorbital subunits. For those patients whose affected brow or double-fold eyelid was inevitably destroyed in operation, hair transplantation, scalp flap transfer and eyebrow tattooing were optional methods for the disappeared eyebrow and double eyelidplasty to the involved upper eyelid. Brow ptosis resulting from some direct or indirect damages [12] can only be corrected by suspension sutures to the periosteum.

This type of flap is a good choice for large mid-facial defect aesthetically reconstruction. The supple flap of even thickness can be suitable for covering the large missing part in these units/subunits including the nose unit, the periorbital unit, partial cheek unit or partially involved these adjacent units.

The expanded paramedian forehead flap can be 1.5-2 times of the non-expanded one in size as the precondition is that the donor site is primarily closed. As the flap is large, selected expander should be inserted under muscular layer for safety. Although it is reported that there is a cutaneous branch from STrA in one-stage nasal reconstruction [13], no literature about expanded forehead flap with its pedicle based on that branch can be referred. When the expanded flap elevated at the second stage, it is unnecessary to dissect the pedicle elaborately for the pedicle is long enough and there may be insufficient blood supplying and venous stagnation occurring under detailed operation. This can be endorsed by the report that a zone of safety 7 mm above the supraorbital rim for the base should be preserved to maximize blood perfusion for three-vessel flow supports through the superior orbital plexus that connects the dorsal nasal, STrA and SOA [14]. The size of the axial pedicled flap can be designed flexibly according to the defect form on condition that it should follow the certain designing principle for axial flap survival.

After expanded forehead flap transferred to lower eyelid zone, slight ectropion sometimes could be observed in our cases. We attributed this appearance to the following possible reasons: The heavy weight of flap, also bloated compared to the normal lower eyelid. The flap retraction and subcutaneously scar constriction after flap transfer. Besides the preventative method that flap planned slightly larger than the defect/lesion, our other remedial measure was performing capsulectomy and then using the method of suspending and fastening that suturing the flap to the periosteum of infraorbital margin intraoperatively. Otherwise, if for fear of damaging the flap blood circulation, flap thinning operation can be raised to flap pachynsis 6-12 months later after scar maturation and surrounding tissue relaxation. The full-thickness expanded forehead flap looks plump by contrast with the normal eyelid skin, but it is suitable for complex defect of eyelid such as facial cleft. What's more, after flap debulking, the forehead flap is still compatible in eyelid region.

The double-pedicled expanded forehead flap is supplied by a pair of temporal vessels [15]. Simultaneously, the single pedicled expanded forehead flap (type IV flap) based on unilateral superficial temporal vessels looks like the "scaled-down version" of type III flap. The STAs and its branches may survive well even scar extended to the temporal area. The pivot point of the expanded flaps is approximately 2-4 cm above zygomatic arch, and the length of pedicle usually ranges from 8 to 10 cm. For the sufficient blood supply and the long pedicles after expansion, type III flap can reach lower face for reconstruct the perioral unit and neck scar contracture and type IV flap can be used in reconstruction of subunits of periorbital and cheek units with very small probability of flap necrosis [16]. The route of superficial temporal artery goes beyond the temporal branch of facial nerve so that frontalis muscle has less opportunity of dysfunction under the principle of the lower margin of pedicle elevated as close to vascular bundle as possible, making pedicle with a width of 3-4 cm. The frontal donor site can be closed primarily at the hairline. The temporal donor sites were temporarily covered by the grafted scarring removed from the recipient site and would be restored by the flap from pedicles at the third stage operation.

Since the frontal donor site can be closed primarily at the hairline, these two types of flap have the advantage that there is no scar in the hairless forehead area. The temporal vessels usually constantly emerge and are relatively easy to be dissected as pedicles. Moreover, the forehead flap can be created with a certain width of scalp if moustache reconstruction needed for patients [17-19]. For perioral reconstruction, it can be windowed safely to reform the mouth simultaneously during flap transplantation.

Based on our own experience and literature review, we come up with the tactics of choosing forehead flaps in terms of deformity location and size. Different faciocervical units reconstruction can utilize diverse types of expanded forehead flap. Although the non-expanded forehead flap is adequately befitting for reconstruction of total or segmental unit [20], the expansion technology can support to decrease deformity of donor-site and thin the flap [21]. In summary, the four types of expanded flaps are more suitable for reconstruction of large defect/lesion in or over one unit. Type Iflap is confined to reconstruct defect/lesion in the area above palpebral fissure. Type II flap and type IV flap have the similar scope of application, mainly situating in middle face, but still have some distinctions. Type II flap can be used to reconstruct total to partial nose, but type IV flap has difficulty in total/subtotal nasal resurfacing [22]. Furthermore, type II flap usually cannot cover lower cheek where type IV flap can reach. In addition, if defect/lesion of mid-face involved partial upper lip, moustache reconstruction [22] by extended type II flap with scalp would be permitted. Type III flap can be applied to reconstruction of lower two thirds of face and upper neck.

For repairing very large defect in face and neck, one single expanded forehead flap always falls short of demand, so it can combine with additional expanders laid under the normal faciocervical skin adjacent to the defect/lesion to create extra skin flaps. In addition, the post-transferred forehead flap can be re-expanded to reconstruct residual scars, nevus or vascular anomalies. Beyond the two methods, different strategies in designing expanded forehead flap can be applied. For both sides of mid-facial reconstruction, type III flap can be employed. In hemi-facial resurfacing, a novel method was

performed using the unilateral pedicled expanded forehead flap with supercharging technology [23,24].

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