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ORIGINAL ARTICLE

Reconstruction of the Cheek after Large Port-Wine Stain Lesion Resection

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Abstract
Background A laser is commonly used in treatment of port-wine stain (PWS). Although observable lightening of the stains can be achieved, complete removal is rare. A significant proportion of lesions are resistant to laser treatment, including hypertrophic lesions and scars developed after improper (unsuccessful) treatments. Alternatively, resection is used to eliminate such lesions, but the reconstruction of the aesthetic appearance of the cheek after large lesion resection remains a huge challenge.
Methods Ten patients with a PWS larger than two-thirds of the cheek were selected for this study. In those patients, prefabricated induced expanded flaps carried by the superficial temporal vessels were prepared to cover the defect areas after resection of the PWS lesion.
Results In eight patients, all the donor sites and defect areas were covered primarily with the expanded flaps, which then survived completely. All patients were satisfied with the cheek appearance after reconstruction with prefabricated induced expanded flaps, which provided a good match for color and texture, restored facial contour, placed scars in a concealed location, and achieved minimal donor-site morbidity. Two of the ten patients did not finish the original surgical plan due to infection or damage to the vascular pedicle.
Conclusion We show that the technique of using prefabricated expanded flaps based on the superficial temporal vessels can be an effective option for repairing large cheek defects after PWS resection.

Keywords Cheek resurfacing · Prefabricated flap · Expanded flap · Superficial temporal facial flap · Port-wine stain

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Port-wine stain (PWS), a type of birthmark, is the most common congenital capillary vessel malformation of the skin. The occurrence rate is 0.3% among newborns. It presents with faint pink macules at birth and mostly appears on the face and neck, representing 80% of the cases. The abnormal face appearance leads to severe psychological problems [1, 2]. PWS does not resolve spontaneously but persists throughout life. Some lesions may even evolve with age. The abnormal capillary vessels dilate gradually and the color of the lesions darkens progressively. The lesions may even become thickened and form nodules and masses. It has been reported that two-thirds of PWS lesions present with excessive hypertrophy and form nodules in patients over 46 years old. As the clinical characteristic of PWS, the nodal lesion may progress to severe hypertrophy and develop a cobblestone pattern, which causes further disfiguration of the facial features and tends to bleed.

The facial disfiguration, the tendency to bleed, and infection require active therapy such as laser treatment, cryotherapy, isotope therapy, or surgical resection. Since the 1960 s, the pulse dye laser (PDL) has been used to treat PWS. Recent advances in technology have greatly improved the effectiveness of laser treatment. However, a significant proportion of lesions are resistant to laser treatment. In particular, PWS on the center of the face is

more likely to recur thereafter [3–7]. Other therapies such as cryotherapy and isotope therapy are used to treat laser-resistant lesions of PWS, which unfortunately are often accompanied with uncontrollable or severe complications such as scarring and permanent pigment change.

When hypertrophic PWS lesions cannot be removed using laser therapy or when scarring develops after unsuccessful treatment, the only effective way to remove those lesions is surgical resection [8]. After PWS resection, skin grafts and transplantation are the traditional choices to cover large cheek wounds, but these approaches often lead to an unsatisfactory facial appearance. Hence, it remains a challenge for plastic surgeons to resurface the cheek and restore the aesthetic facial appearance after surgical resection of PWS lesions.

Here we report our attempts to resurface the cheek by using local expanded prefabricated flaps in ten selected patients with PWS larger than two-thirds of the cheek.

Patients and Methods

Patients

We performed an institutional board-approved retrospective review of our database of patients who underwent facial reconstruction following PWS lesion resection between August 2008 and August 2010 at our institute. Ten patients with cheek PWS were scheduled to undergo lesion resection and reconstructive surgical therapy using prefabricated expanded flaps carried by superficial temporal fascial flaps. These patients (5 male, 5 female), whose ages ranged from 14 to 53 years old (average = 29.6 years old), all had PWS lesions covering the major parts of the cheek and other subunits of the face such as the temporal, nasal, and upper-lip regions. The size of the lesions on the cheek ranged from 12.5×6 cm to 15×11 cm. Four patients had PWS lesions with hypertrophy and nodules, whereas the other six patients had scarring after isotope therapies for facial PWS.

Surgical Techniques

After resection of the PWS lesions, the cheeks of all patients were scheduled for reconstruction using prefabricated expanded flaps carried by superficial temporal fascial flaps. Normal skin from the paramandibular region, without the PWS, was employed as the donor site. The surgical procedure was performed in two stages.

First Stage

The first stage of the operation was prefabrication of the expanded flap carried by the superficial temporal fascial flap, which extended from the parietal branches of the superficial temporal vessels. The donor site, the paramandibular region of the face, was dissected in the deep subcutaneous layer to form a soft-tissue pocket for the expander. The fascial flap containing the parietal branches of the superficial temporal vessels was rotated down to the paramandibular area through a subcutaneous tunnel and then fixed in the deep subcutaneous layer in the prepared pocket. An expander was buried under the fascial flap. A second forehead expander was prepared in some of the patients whose PWS lesions involved not only the cheek but also other subunits of the face, such as the temporal, nasal back, and upper-lip regions. Two weeks after the first operation, the expansion was started with 0.9% NaCl injections twice a week until the expansion was finished.

Second Stage

The second stage of the operation was resection of the PWS lesions and reconstruction of the cheek. Before the second operation, the prefabricated vessels were evaluated by Doppler ultrasonic wave detection. After resection of the PWS, the expanders were removed, and cheek reconstruction was performed subsequently. If the lesions were beyond the cheek area, and thus could not be completely covered by the prefabricated flap, the forehead expanded flap was employed. In all cases, the prefabricated expanded flaps were used to cover both the wound and donor site of the cheek, thereby reconstructing the facial contour.

Results

Among the ten patients, only two did not complete the scheduled surgical operation. One patient with a hypertrophic PWS lesion could not undergo the operation because of infection. We were not able to identify the source of the infection, but very likely it was due to sanitary conditions and personal hygiene habits. It is worth noting that the hypertrophic lesion itself increases the risk of infection. The other patient who participated at the beginning of this study, did not successfully finish the second operation because of the inadvertent damaging of the prefabricated vessel. Without the prefabricated vessel, the distal end of the expanded flap experienced necrosis within 1 week after the first operation. Because of this experience, we always protect the vascular pedicle with a sheet of silicon, which was able to prevent vessel damage effectively during the second stage of the operation in our study.

The surgical operations in the remaining eight patients were performed as planned. After surgery, the prefabricated expanded flaps completely survived, and the patients

Table 1 Summary of patient data

Patient no.	Sex	Age (years)	Etiology	Resection size (cm × cm)	Face subunit reconstruction with prefabricated flap	Follow-up (months)
1	Male	32	Hypertrophic PWS	14 × 9	Cheek, part of temple and upper lip	2
2	Female	29	PWS scarring	12.5 × 6	Cheek, part of upper lip	14
3	Female	33	Hypertrophic PWS	14 × 12	Cheek, part of nasal and upper lip	22
4	Male	14	PWS scarring	11 × 9	Cheek, part of upper lip	22
5	Female	30	Hypertrophic PWS	15 × 11	Cheek, part of nasal and upper lip	15
6	Female	23	PWS scarring	13 × 11	Cheek, part of nasal and upper lip	6
7	Female	30	PWS scarring	14 × 8	Cheek	6
8	Male	22	PWS scarring	14 × 9	Cheek, part of nasal and upper lip	9
9[a]	Male	30	PWS scarring	–	–	–
10[b]	Male	53	Hypertrophic PWS	–	–	–

[a] Patient number 9 did not finish the original surgical plan due to vascular pedicle damage

[b] Patient number 10 did not finish the original surgical plan due to local infection during the expanding procedure

were satisfied with the contours of their facial reconstruction. During the 2-22-month follow-up, the PWS did not recur in all cases.

As summarized in Table 1, the size of the superficial temporal fascial flap from these eight patients varied from 4 × 10 cm to 7 × 15 cm (average size = 5.4 × 11.9 cm). The expansion period ranged from 66 to 221 days (average = 142.3 days) and the size of the expander in the paramandibular region ranged between 100 and 300 ml. The volume of inflation ranged from 250 to 450 ml (average = 378.8 ml). Before the second operation, the pulse of the prefabricated vessels of all the patients could be detected by Doppler ultrasonic wave. In some cases, before the second operation, the prefabricated vessels were marked on the expanded flaps under three-dimensional ultrasonic wave navigation (GE-Voluson E8), which showed that the prefabricated vessels represented some of the major irrigating arteries for the flaps. The size of the recipient site after removal of the PWS lesions ranged from 12.5 × 6 cm to 15 × 11 cm (larger than two-thirds of the cheek). Finally, the prefabricated expanded flap was used to cover the wound and donor site of the cheek and thereby reconstruct the facial contour. During the 2-22-month follow-up, no abnormal sensitivity of the flap was recorded, and the motility of facial expression was not affected.

Typical Cases

Case 1

A 33-year-old woman presented with hemifacial PWS, which was hypertrophic and contained a huge nodule. Apart from the cheek units, the PWS lesion involved temporal, nasal, and oral regions of the right face. The lesion size was about 20 × 14 cm. In the first stage of the operation, the fascial flap from the parietal branch of the superficial temporal vessel, which measured 15 × 7 cm, was transferred to the subcutaneous layer of the paramandibular region, and a 100-ml expander was buried under the superficial temporal fascial flap. Another expander, with an 80-ml capacity, was buried under the forehead as the donor site for reconstruction of the nasal and oral region after the PWS resection. The expanders were inflated over 109 days. The inflation volume of the paramandibular region expander was 330 ml and that of the forehead region expander was 180 ml. Before the second operation, the pulse of the prefabricated vessels was detected by Doppler ultrasonic wave. After resection of the PWS lesion (14 × 12 cm) at the level where the orbital and the ear meet, the prefabricated flap was transferred as a pedicle flap to cover the defect and reconstruct the cheek, nasal, and oral regions. After surgery, the skin flap of the prefabrication survived, and the forehead expander flap was removed. The forehead skin gradually returned to its original state. This reconstruction yielded an aesthetically satisfactory cheek. The color and texture of the skin flap of the reconstructed cheek were similar to those of the contralateral side (Fig. 1). The scar along the marionette line down to the neck in this case is hypertrophic and was caused by high tension at that site. Additional measures were taken to decrease the tension and to prevent scar hypertrophy in the cases that followed. First, we prepared more expanded tissue to cover the wound at the zone near the marionette line to reduce the tension. Second, we used medical needleless wound suture (Sichuan lichen Medical & Pharmaceutical Technology Co., Ltd, China) to decrease the tension after operation. Expected results were observed in later cases, as shown in cases 2 and 3.

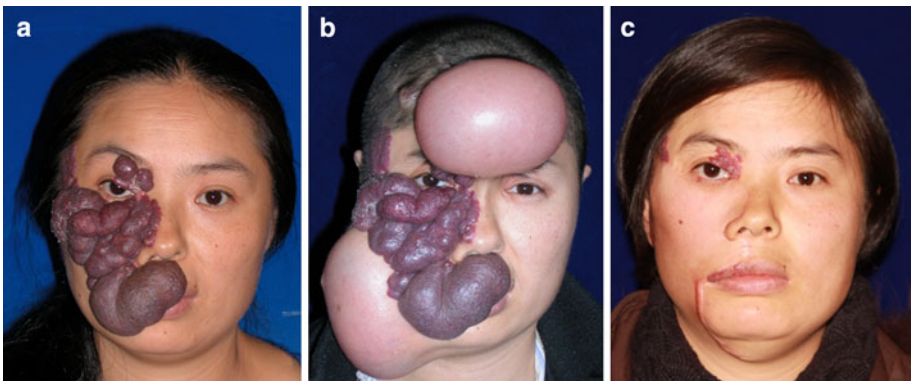

Fig. 1 Views in case 1. **a** Hypertrophic PWS on the face. **b** The prefabricated expanded flap was prepared. **c** After PWS resection, the cheek was resurfaced with a prefabricated expanded flap. Postoperative views at 1-year follow-up

Case 2

A 22-year-old male presented with scarring and pigmentation due to isotope therapy for PWS on the right cheek. The lesion was about 14 × 9 cm and could not be camouflaged by makeup. After PWS lesion resection, cheek resurfacing was performed with a prefabricated, induced, expanded flap after expansion with a 180-ml expander to 420 ml over 140 days. The skin flap of the prefabrication survived. The surface of the reconstructed cheek was quite flat and expansive with uniform contour. The color and texture of the skin of the reconstructed cheek matched that of the contralateral healthy side (Fig. 2). With enough expanded tissue covering the lower-eyelid area for flap contracture postoperation, ectropion symptoms did not happen.

Case 3

A 32-year-old male presented with a hypertrophic PWS lesion on the right side of the face involving the cheek, temple, and part of the upper-lip. The lesion size was about 17 × 8 cm. In the first stage, a prefabricated expanded flap carried by the superficial temporal fascial flap and a forehead-expanded flap were utilized. In the second stage, after resection of the PWS lesion (14 × 8 cm), the cheek was reconstructed with a prefabricated induced expanded flap after expansion with a 150-ml expander to 450 ml over 165 days. Before and after the second stage of the operation, three-dimensional ultrasonic wave detection showed that the prefabricated vessel was one of the major arteries irrigating the flap. The skin flap of the prefabrication survived and the forehead-expanded flap was not used. The surface of the reconstructed cheek was quite flat, expansive, and uniform in contour (Fig. 3). The motility of the reconstructed cheek was not affected (Fig. 4). The tissue characteristics of the skin from the paramandibular region are similar to that of the cheek and suitable for reconstruction of the cheek. However, it is too thick to replace the lateral canthus thin skin. PWS lesions in the lateral canthus area were left. We plan to try nonsurgical (e.g., laser) or other surgical therapy (such as local tissue flap) to remove the residual lesions at the lateral canthus region.

Discussion

The living face is the most important organ of the human being and is involved in emotional expression and nonverbal communication. The cheek includes four subunits (infraorbital, zygomatic, buccal, and parotideomasseteric) and is the major component of the face. Obviously, cheek deformities will have a significant negative impact on interpersonal perception and social functionality. Therefore,

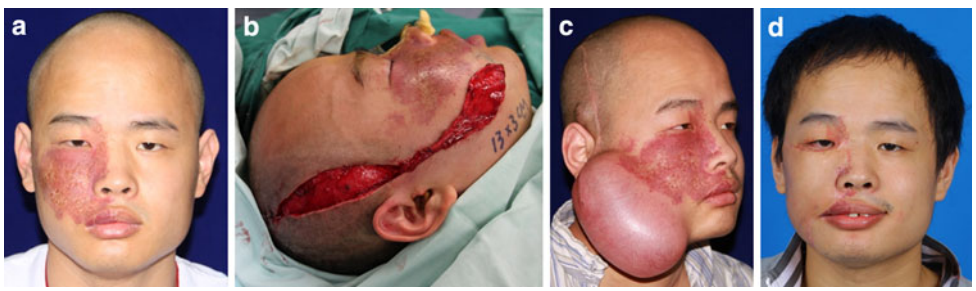

Fig. 2 Views in case 2. **a** Cheek scarring and pigmentation due to isotope therapy for PWS. **b** The parietal branch of the superficial temporal vessel fascial flap was transferred to the paramandibular region. **c** The prefabricated expanded flap was ready. **d** The cheek was resurfaced through use of a prefabricated expanded flap. Postoperative views at 6-month follow-up

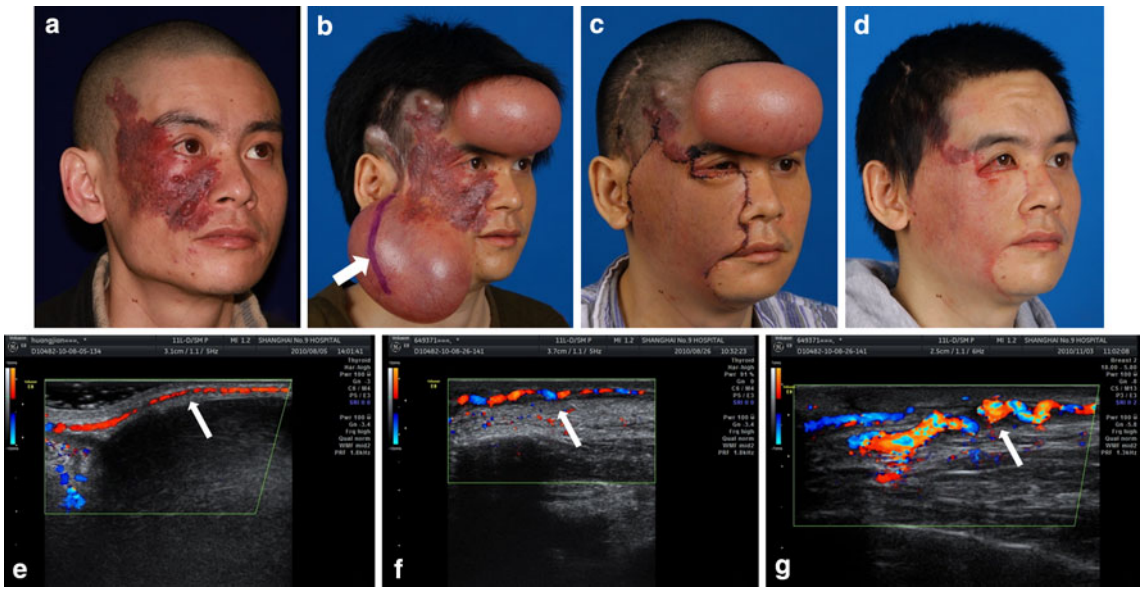

Fig. 3 Views in case 3. **a** Hypertrophic PWS on the face. **b** The prefabricated expanded flap was prepared. Before the second operation, the blue line (arrow) was used to mark prefabricated vessels on the expanded flaps with ultrasonic wave navigation. **c** The cheek was resurfaced with a prefabricated expanded flap. Postoperative views at 6-day follow-up. **d** Postoperative views at 2-month follow-up. The forehead expanded flap was not used and the expander was removed. **e** The images show the patency of the prefabricated vessel (arrow) under ultrasonic wave 15 days before, **f** 6 days after, and **g** 2 months after the second stage of the operation

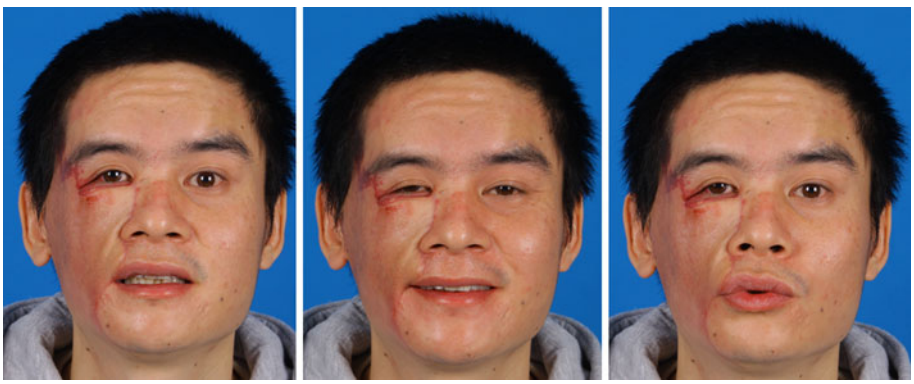

Fig. 4 Motility in the reconstructed cheek 2 months after the second stage of the operation from case 3

PWS malformation on the cheek needs to be treated aggressively. Surgical resection is the only method that can effectively eliminate hypertrophic or scarring PWS lesions. After PWS lesion resection, cheek reconstruction becomes of paramount importance because normal cheek appearance is vital for self-esteem, employment, and the ability to interact in society successfully [9].

The goal of cheek reconstruction is to transform a deformed surface into a normal, acceptable appearance. Ideally, reconstruction of soft-tissue facial defects should provide a good match for color and texture, fully restore the contour of the face, place scars in a concealed location, and achieve minimal donor-site morbidity.

There are many options available to resurface large soft-tissue defects of the cheek, including split- and full-thickness skin grafts, regional skin flaps such as cervical rotation flaps, and the transfer of a microvascular free flap [10]. However, split-skin grafts, full-thickness skin grafts, or microvascular free flaps may result in unacceptable cosmetic appearances such as mask-like facial expressions or flaps of abnormal thickness, which rarely satisfy patients or surgeons [8]. Therefore, the use of split- and full-thickness skin grafts or microvascular free flaps derived from distant tissue is not considered the first choice for treatment. Color and texture are comparable to those of the skin lost by excision only when tissue adjacent to the defect is used for reconstruction. Therefore, the ideal donor site for tissue used to treat the cheek defect is derived from an adjacent flap. If the defect is smaller than 30% of the cheek unit, it can be repaired by primary closure or a local flap. If the defect is larger than 30% of the cheek unit (6–10 cm), the extensive mobilized random cervical face flap is used [11].

The cervical face flap has good viability and yields excellent cosmetic results, with the facial scars running in the normal expression lines. The donor site is closed inconspicuously. However, for a large defect, extending over more than two-thirds of the entire cheek, a large and extensive cervical face flap is needed and the risk of distal-edge necrosis arises. This risk is particularly high when the flap must be sutured under tension because of the size of the defect. In such situations, it is useful to provide a large amount of donor tissue to decrease the tension when suturing, or to have a means of improving the blood supply and hence improving the reliability of the flap.

In our series, the PWS involved more than two-thirds of the cheek unit. Obviously, it is difficult to repair such large defects of the cheek and cover the donor area, even with the use of extensive cervical face flaps. We expanded the residual normal tissue on the face adjacent to the PWS lesion adequately before transferring it to cover the defects after PWS resection [12, 13]. After expansion, the surface area of the skin flap was large enough to cover both recipient and donor areas; however, in the paramandibular region, no axial vessel is available for expansion of the skin flap [14]. Without an assured blood supply, survival of the expanded flap cannot be expected. "If more transposition than flap advancement is needed, undermining must be limited because peripheral incisions will divide the horizontal blood supply" [11], which increases the risk of necrosis of the distal part of the expanded flap, especially in the regions near the infraorbital, nasal back, and upper lip. Therefore, the advancement of the expanded flap is limited. In order to guarantee the blood supply of the expanded flap, many authors report using serial tissue expansion to finish flap advancement and to cover an extensive wound step by step. However, this requires extensive multiple operations or a longer therapy time [15, 16].

In 1982, Yao [17, 18] proposed the idea of the prefabricated flap for use when no axial vessel was available to aid flap survival. The prefabricated axial vessel could be transferred to improve the blood supply of the flap lacking an axial artery. It has been demonstrated that the blood supply of the prefabricated flap is more robust than that of random-pattern flaps [19–22].

Therefore, in our clinical practice, we transfer the parietal branch of the superficial temporal vessels to the paramandibular region through a subcutaneous tunnel. With completion of the expansion procedures, the prefabricated vessel is formed and developed to become one of the major blood vessels supplying the expanded flap. When the axial vessel flap is formed, the arterial supply of the expanded flap is improved. Then, the expanded flap can be used as a pedicle flap with axial vessels. As a result, the prefabricated expanded flaps can be used to cover nearly all of the cheek. The flap is able to reach the edge of the ipsilateral inferior eyelid, nasal sidewall, and even the upper lip with good blood supply. The shape of the flap can be molded according to that of the contralateral healthy side. After shaping and stitching without tension, the profile of the face is reconstructed. With enough tissue, definite blood supply, and good motility, the incision can proceed along the inferior eyelid edge to the medial canthus, passing inferiorly along the nasal sidewall into the nasolabial fold and marionette line around the chin. After the operation, most of the incision scars are hidden under the skin fold, similar to a Webers-Fergusson incision, which avoids a scar in the middle of the face. The prefabricated expanded flap covers the entire cheek and reconstructs the facial profile without destroying the face's integrity.

Conclusions

In our study, after two stages of operation, the prefabricated expanded flap restored aesthetic facial appearance with optimal tissue-texture match. Such a technique, which combines the use of an expanded flap with a prefabricated arterial supply, may advance the field of cheek reconstruction to achieve improved aesthetic and functional outcomes.

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