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Treatment of Postburn Ear Defect With Expanded Upper Arm Flap and Consequent Expansion Without Skin Grafting

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Abstract: Total ear reconstruction in the postburn auricle is one of the most challenging procedures for plastic surgeons. Adverse factors associated with these procedures include reduced or damaged blood supply, poor elasticity of scar tissue, increased risk of infection, and the possible destruction of skin, temporoparietal fascia, or retroauricular fascia. In cases where patients are severely burned, free flaps, such as radial forearm flaps, contralateral temporoparietal fascial flaps, or omental flaps, can be used as framework envelopes. In this work, we introduced a novel method of expanded upper arm flap transfer, followed by an expansion method of total ear reconstruction without skin grafting.

Key Words: postburn ear, total ear reconstruction, upper arm flap, expansion method

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Burned ear deformities can result from direct thermal injury or subsequent chondritis.¹ The degree of postburn deformity is divided into several levels according to the state of the auricle, skin around the auricle, subcutaneous fat, temporoparietal fascia, and retroauricular fascia, superficial temporal vessels.

For postburn ear deformities, conventional repair methods include temporoparietal fascia combined with skin grafting,^{2–5} contralateral temporoparietal fascial flap transfer,⁶ composite prefabricated free flap transfer,^{7,8} and auricular prosthesis.^{9–11} Materials for ear framework include autologous rib cartilage,^{2–5} silicone, and porous polyethylene.¹²

Undesirable ear reconstruction may be ascribed to a thick or inadequate skin envelope, such as hypertrophic scar tissue, or one containing a thick or insufficient expanded flap; the carving technique of the cartilage framework; or may due to the feasibility of the local flap or free flap.

The preexpanded lateral upper arm flap has been widely used for facial reconstruction¹³; however, a reliable technique has not yet been reported for ear reconstruction. The expanded lateral upper arm,

which has thin skin and causes no additional defects, is an ideal flap for acquiring better ear definition. Here, we report a case of expanded upper arm flap transfer and repeated expansion for total ear reconstruction without skin grafting. This method is suitable for burned ears with an unavailable local flap or free flap.

METHODS

The procedure for this technique can be divided into the following 6 stages: (1) implantation of tissue expander at the inner upper arm; (2) expander removal and skin tube formation, left-sided scalp expander insertion; (3) skin tube transfer to ear region; (4) skin tube depedicle, upper arm and retroauricular expander implantation; (5) expander removal and rib cartilage framework insertion; and (6) expander removal and expanded scalp flap coverage.

RESULTS

Case Report

A 20-year-old woman presented to an ear reconstruction center with a marked right-sided craniofacial postburn deformity that was caused by contact with a flame 19 years ago. On physical examination, gross right-sided baldness, scar tissue, and a subtotal ear defect were noted. The patient's postauricular and temporoparietal fascia were destructed (Fig. 1). This patient was classified to group IV as neither the skin in and around the auricular region or the local fascial flap was available.

We planned pedicled upper arm flap transplantation, which is different from the conventional free flap method. Two soft tissue expanders of 100 and 150 mL were implanted into subcutaneous layer of the patient's upper right arm. Ten days postoperatively, saline injections were administered to the patients 2 to 3 times a week. After a total injection of 480-mL saline and a 1-month static expansion phase, we carried out skin tube formation for skin flap delaying, to ensure blood supply to the skin flap (Fig. 2). A 50-mL expander was implanted spontaneously in the distal skin tube to prevent skin flap contracture (Fig. 3). Twenty-five days later, the pedicled medial upper arm antegrade flap was transplanted to the ear region (Fig. 4). After interrupted skin tube training, a pedicle division was applied 4 weeks later. A 50-mL kidney-shaped soft tissue expander was implanted in the subcutaneous layer of the remaining flap in the same stage. The wound was sutured into 2 layers and a suction drain was inserted for 3 days. Saline injection of 3 to 8 mL was carried out 3 times a week and sutures were removed 14 days postoperatively. After injection of 141-mL saline (during a duration of 3 months), a 1-month static expansion phase was needed before beginning the next stage of ear reconstruction (Fig. 5). Costal cartilage harvesting and framework fabrication are generally used as the expansion method for primary cases without capsule removal. Seventh and eighth rib cartilage were harvested from the right side of patient's chest and the ear framework was fabricated using the splicing method. The seventh rib cartilage was cut into 3 blocks as follows: the upper part (augmentation part), middle part (triangular fossa), and lower part (base frame). The antihelix part was carved from the base frame, which is also a procedure in scaphoid fossa formation. The helix part was harvested from the outer convex of seventh or eighth costal cartilage.¹⁴ The structures were fixed by 0.2-mm-diameter titanium wire and 5-0 Vicryl suture. Drainage was retained for 5 days, and

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FIGURE 1. Lateral view showed burned ear defect with hemicranial alopecia.

FIGURE 2. Preexpanded lateral upper arm.

sutures were removed 10 days postoperatively. The reconstructed ear contour showed good definition (Fig. 6) and we found additional donor site scars to be inconspicuous (Figs. 7 and 8).

During the stage of skin tube formation at the right upper arm, 2 additional 300-mL rectangular tissue expanders were implanted beneath the left side of the patient's scalp (Fig. 6) followed with 6 months

FIGURE 3. Right upper arm skin tube formation.

FIGURE 4. Skin tube transfer.

of saline injection and 1 month of static expansion. Sufficient expanded scalp flap was transferred for coverage of the patient's left-sided hemicranial scar, and the rearranged hair provided a desirable lateral review (Fig. 9).

DISCUSSION

Postburn ear reconstruction presents a large problem for plastic surgeons. Although the Nagata technique is suitable for mild cases with good skin condition,^{3–5} more severe cases can be associated with multiple adverse factors that influence the survival of the reconstructed ear and its contour. Further, poor elasticity of scar tissue may result in poor subunits, and using scar tissue expansion, which presents a larger chance of infection, expander rupture and framework exposure, may not improve the result. Driscoll and Lee have reported 3 cases of burned ear reconstruction by soft tissue expansion combined with porous polyethylene, with alopecia resection and expanded scalp flap coverage performed in the same stage. Additionally, with a better exposure, the temporoparietal fascia was

FIGURE 5. Mastoid region skin flap expansion, obvious vessel regeneration was detected.

FIGURE 6. Reconstructed ear with good definition, expanded scalp flap.

draped over the porous polyethylene.¹² Using this approach, blood supply to temporoparietal fascia or retroauricular fascia was also damaged, making the latter into a random fascial flap.

Several methods of free flap ear reconstructions have been reported. Brent and Byrd reported excision of heavy auricular scars, followed by rib framework placement. Subsequently, an axial, random, or free temporoparietal fascia was draped over the framework and covered by skin graft.² Park and Suk Roh⁶ reported 16 cases of total ear reconstruction by contralateral temporoparietal fascia free flap, skin grafting, and costal cartilage framework; Chiang reported a 3-stage procedure for reconstruction of scarred microtia. In this work, rib framework was inserted into the expanded distal forearm, followed by microsurgical transfer of the composite forearm flap.⁸ Others have resorted to auricular prosthesis.^{9–11}

FIGURE 7. Donor site of right upper arm with hidden scar.

FIGURE 8. Donor site of right chest with inconspicuous scar.

The expanded upper arm flap has been widely applied for facial restoration. However, it has not been reported in ear reconstruction. Compared with skin grafting, the expanded flap provided a better condition of elasticity. The secondary expansion period was a procedure of skin flap training, which could lead to accelerated blood supply, a normal phenomenon that occurs during ear reconstruction, as well as providing a thinner pocket for a better auricular definition.

FIGURE 9. Ten days after expanded scalp flap transfer.

Expansion of the skin flap is more reliable than use of scar tissues with uneven thickness.

McCauley et al¹⁵ classify alopecia into types I to IV, according to the extent of alopecia on a patient's scalp less than 25% of the scalp, 25% to 50%, 50% to 75%, or greater than 75%. Expansion of the hair-bearing scalp flap transfer is an ideal method for cases where alopecia accounts for greater than 50% of a patient's scalp. Meanwhile, in consideration of possible flap necrosis and framework exposure, random temporoparietal fascia can be reserved for salvage. Thus, expanded scalp transfer is placed last. With an adequate period of scalp expansion and a static expansion phase, the hemicranial alopecia can be restored in 1 stage.

In conclusion, we consider expanded upper arm flap and hair-bearing scalp as a safe and simple method for repairing postburn ear defects and scalp alopecia. However, the multiple procedures and long expansion period associated with these procedures may restrict their application.

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