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Reconstruction of the postauricular defects using retroauricular artery perforator-based island flaps

Anatomical study and clinical report

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Abstract

The objectives of the study were to introduce and investigate the reliability of a new flap for postauricular defects using the retroauricular artery perforator.

Twenty auricles from 10 Asian human cadavers were dissected to examine the retroauricular perforator distribution and diameter. Fourteen patients with postauricular defects underwent reconstruction using the retroauricular artery perforator from 2013 to 2015. After locating the position of the perforator by ultrasound Doppler blood flow detection, a suitable flap was designed according to the defect's size, condition, and distance from the pedicle. The flap was meticulously elevated, rotated appropriately, and sutured to the defect. The donor site was then closed.

Cadaver dissection showed that the posterior auricular artery produces at least 2 constant branches with an external diameter of 0.84 ± 0.25 mm at the origin. These branches proceed toward the mastoid process at the height of the auriculocephalic angle to nourish the skin and fascia. A total of 14 clinical cases were available for 3 to 12 months postoperative follow-up. All flaps survived completely, maintaining good skin color, perfect outer contour, and complete patient satisfaction with the aesthetic results after initial treatment.

Retroauricular artery perforator-based island flaps appear to be ideal for 1-stage reconstruction of postauricular skin defects.

Abbreviations: AFI = auricular fascial incisura, BCC = basal cell carcinoma, ECA = external carotid artery, EPF = extrinsic postauricular fascia, IP-RIFs = inferior pedicle RIFs, PAA = posterior auricular artery, P-RIFs = perforator RIFs, RIPs = retroauricular island flaps, SP-RIFs = superior pedicle rIFs, STA = superficial temporal artery.

Keywords: perforator flap, postauricular defect, vessel anatony

1. Introduction

Postauricular skin defects are caused by tumorigenesis, trauma, and infection. Reconstruction of the postauricular surface in an aesthetic manner is a challenge. An ideal flap for the repair of postauricular skin should be thin and flexible, match the recipient site in color and not have a donor-site scar. Therefore, a proximal flap should be the first choice. Many methods of auricular reconstruction with a regional flap have been documented, including random flaps and pedicle flaps, from retroauricular skin.[1,2]

Retroauricular skin is considered a skin flap bank from which a suitable flap may be selected for reconstruction of any defect of the anterior surface, the lobule, or, occasionally, the free margin.[2] Retroauricular artery perforator-based island flaps are considered practical regional flaps for repairing defects of the helical rim, temporal area, and concha,[1,2] but few reports have described the use of a rotational flap to repair the postauricular surface. Descriptions of a reliable perforating blood supply to the flap have been inadequate.

We investigated the vascular supply to the opisthotic skin by cadaver dissection and found that the PAA (posterior auricular artery) provides at least 2 constant branches to the mastoid process at the vertical auriculocephalic angle to nourish the skin and fascia. We used the retroauricular artery perforator as the pedicle of the retroauricular revolving island flap to reconstruct the postauricular defect. From January 2013 to January 2015, 14 cases of postauricular skin defects were reconstructed using retroauricular artery perforator-based rotating island flaps. One case also involved a regional flap.

2. Patients and methods

2.1. Anatomical study

A total of 20 auricles from 10 human cadavers (all Asian, 4 men, 6 women) provided by the Department of Anatomy, Second Military Medical University, were used in this study. The average age of the patients at the time of death was 50.7 years (range:

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32–78 years). After all cadavers were immersed in a 10% formalin solution, red latex was injected into the ECA (external carotid artery). Dissection was assisted by a 2.5-magnification loupe.

All cadavers were placed in the supine position with the neck area exposed. Two transverse incisions were made along the inferior margin of the mandible and the superior margin of the clavicle, and a vertical incision was made between the mid-point of the chin and the supraclavicular fossa. The ECA trunk was located in the carotid arterial region after removing the sternocleidomastoid. Separation along the ECA exposed, the PAA at the superior edge of the digastric and stylohyoid muscles.

The retroauricular perforator artery was identified via an exploratory incision close to the auriculocephalic angle. The chromogenic vessels that nourish the skin were traced back to the original artery. Only 1 major vessel that reached the skin, which ascended from the PAA, was identified as a perforator. The length of the longest perforation was measured using a Vernier caliper, and the diameters of the retroauricular perforators were measured under a dissection microscope (Stemi SV11; Zeiss, Jena, Germany) using a grid (2 mm in 200 parts; E. Leitz GmbH, Wetzlar, Germany).

2.2. Clinical cases

The study protocol was approved by the local ethics review committee of the Second Military Medical University, and all participants provided us with written informed consent prior to inclusion.

A total of 14 patients (6 men and 8 women) aged 55 to 75 years underwent surgery between January 2013 and January 2015. The average follow-up time was 8 months (3 to 12 months). Postauricular defects were most commonly caused by seborrheic keratosis (n=7, 50%), followed by carcinoma (n=5, 35.7%); and trauma (n=2, 14.2%). The flap sizes ranged from 1.5×2 cm to 3×3.5 cm.

2.3. Surgical technique

Prior to surgery, Doppler flow imaging was used to confirm the position of the PAA and the perforator, which were marked at the mastoid process. After the defect was identified, a flap of suitable size was designed on the skin surrounding the auriculocephalic angle. The amount of the flap used to reconstruct the defect was based mainly on its longitudinal axis after rotation. To create a better arc of rotation, the pedicle designed on the retroauricular perforator was set on the margin of the flap.

The flap was superficially elevated to the deep fascia from the caudal border, which was primarily incised to the cephalic border. The dissection was performed meticulously in the area surrounding the retroauricular perforator. A magnification loupe was used when necessary. After assurance that the perforator was contained in the pedicle and confirmation of tension-free flap rotation, the cephalic border was incised to form an island perforator flap. To avoid a "dog ear" appearance after the operation, the cephalic skin was appropriately separated from the subcutaneous tissue. After rotation to the postauricular defect, the flap was sutured in layers. The donor site was closed, and a drain was placed (Fig. 1).

3. Results

3.1. Cadaver study

Skin from the retroauricular surface constitutes a perfect donor for regional flaps. The retroauricular surface is mainly supplied by the PAA network, and the retroauricular artery has a large number of arterial perforators that constantly supply the posterior auricular surface from the mastoid process to the height of the lobulus auriculae, which was observed in all dissections.

The PAA originates from the ECA (17 of 20, 85%) or the occipital artery (3 of 20, 15%). The PAA ascends from the parotid and then passes through the groove between the auricular cartilage and the mastoid process, where 3 to 5 branches connect to the postauricular surface to supply the auricular cartilage and skin along with branches from the STA (superficial temporal artery). The PAA terminates on the parietotemporal area of the posterior auricular surface. Although the origin of the PAA varies, this variation has little effect on the feasibility of using a retroauricular perforator flap. The perforator maintains a relatively consistent course in the area, surrounding the mastoid process at the posterior auricle. It has an external diameter of 0.804 ± 0.25 mm at its origin and a length of 12 ± 3.9 mm (Table 1, Fig. 2).

3.2. Clinical cases

Two patients developed light venous congestion in the early postoperative period, which lasted for ~6 days. Although no special treatment was required, close observation was needed (Fig. 3). After 3 months to 1 year of follow-up, all incisions exhibited primary healing, and no cases of flap necrosis, tumor recurrence, scar contracture, or bulky appearance were observed.

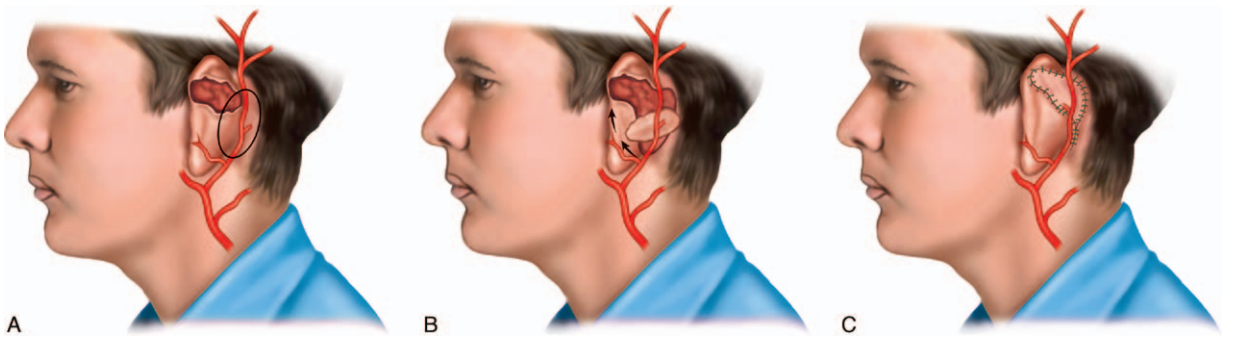

Figure 1. (A) Design of the flap depends on the size of the defect. (B) The flap is elevated and rotated to the defect with the perforator in the pedicle. (C) The flap was sutured layer by layer without tension and the donor site is closed directly.

Table 1

Summary of cadaver dissection study.

Dissection no.	Side	Age	Sex	No. of retroauricular perforator	Diameter of retroauricular perforator (mm)	Length of retroauricular perforator (mm)
1	L	51	F	2	0.94	15
1	R	51	F	3	0.62	9
2	L	46	M	2	0.9	14
2	R	46	M	4	0.81	13
3	L	32	M	2	0.57	8
3	R	32	M	1	0.68	9
4	L	57	F	3	0.56	7
4	R	57	F	5	0.83	9
5	L	39	F	2	1.04	18
5	R	39	F	1	0.44	7
6	L	78	M	3	0.55	8
6	R	78	M	2	1.12	17
7	L	43	M	2	0.74	10
7	R	43	M	5	1.02	16
8	L	40	M	3	0.84	10
8	R	40	M	2	0.62	9
9	L	53	F	3	0.84	12
9	R	53	F	1	1.15	19
10	L	68	M	1	0.87	14
10	R	68	M	2	0.94	16
Total (Average ± SD)		50.7		2.45 ± 1.2	0.804 ± 0.2	12 ± 3.9

F = female, L = left, M = male, R = right.

All flaps survived completely, maintaining good skin color, perfect outer contour, and soft elasticity. Satisfactory function was achieved, and all patients were satisfied with the aesthetic results achieved after the initial treatment (Table 2).

3.3. Typical case 1

A 65-year-old female patient was hospitalized due to a left postauricular tumor that was present for 10 years and had been ulcerated for 2 months. It was firm, moveable, painless, and nontender and exhibited a cauliflower-like appearance. The biopsy results yielded a diagnosis of BCC (basal cell carcinoma). A 2.5 × 4.0-cm skin defect was obtained after adequate margins of the BCC were achieved. A histological examination showed that the BCC was completely removed. We designed a 2.5 × 3.5-cm retroauricular artery perforator-based island flap that rotated almost 150° to cover the defect. The wound healed well without complications, and the patient was satisfied with the aesthetic result (Fig. 3).

3.4. Typical case 2

A 68-year-old woman presented with 2 tumors on the right ear, which were discovered 20 years prior and had recently increased in size. The biopsy results yielded a diagnosis of seborrheic keratosis. After sufficient resection, 2 defects were created, 1 on the postauricular surface (2 × 1.5 cm) and the other on the helical rim (3 × 2 cm). We dissociated the residual skin between the 2 defects as a local flap and then sutured it to the helical rim of the defect. A 2.5 × 4 cm retroauricular artery perforator-based island flap that was rotated nearly 100° was designed to cover the defect on the postauricular surface. The wound healed well without any complications. Additionally, the flap survived completely with good skin color, and the cosmetic result was acceptable (Fig. 4).

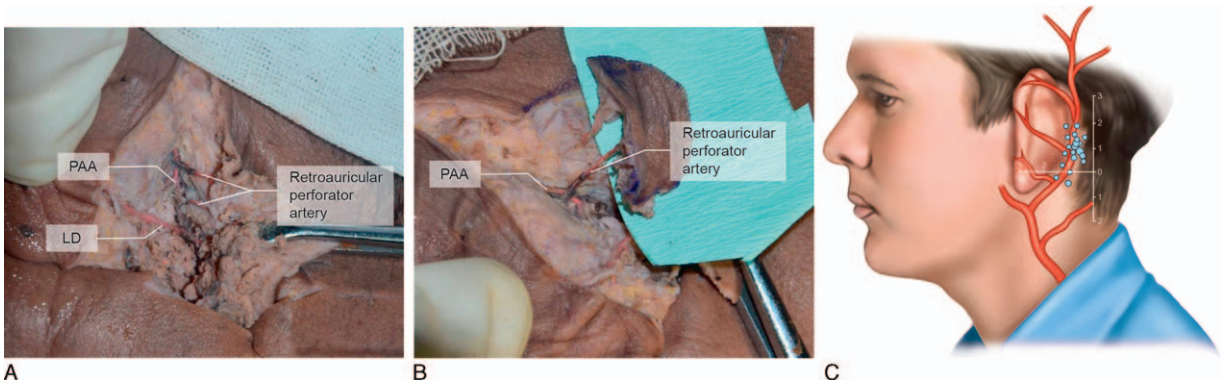

Figure 2. (A, B) The retroauricular artery perforator rises from the PAA around the mastoid process area. (C) The origin points of the retroauricular perforators are represented, the size of circle is according to the external diameter. The horizontal axis through the low edge of the mastoid process and the vertical axis through the back edge of the mastoid process. The scale bar=1 cm. PAA = posterior auricular artery.

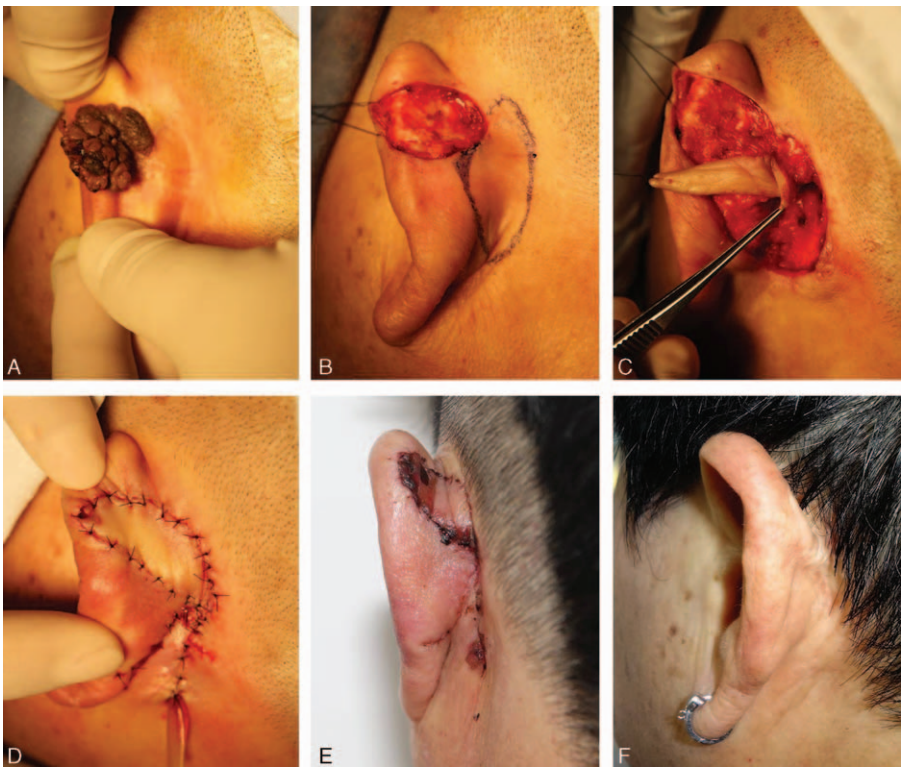

Figure 3. Comparison between preview and postview. (A) Preview. (B) Design the Retroauricular Artery Perforator-based Island Flap after the complete resection. (C) Dissected the flap and rotated to the postauricular defect. (D) Suture of the flap to the defect and the donor site directly with drainage setting. (E) Venous congestion at 1 week follow-up. (F) Satisfactory result at 1 year follow-up.

4. Discussion

This study investigated the utility of the perforator network as a pedicle for RIPs (retroauricular island flaps) and demonstrated the advantages of this technique for postauricular defect reconstruction. Retroauricular skin is considered an ideal skin bank for ear reconstruction, and various RIFs have been used for the reconstruction of ears.[3–8] Cordova et al[9] classified RIFs into 3 groups: SP-RIFs (superior pedicle rIFs), which are used for defects of the upper half of the auricle, P-RIFs (perforator RIFs) used for conchal reconstruction, and IP-RIFs (inferior pedicle RIFs) used for reconstruction of nonmarginal and superficial marginal defects of the auricle. In 2011, Youn et al[10] reported the successful reconstruction of a large helical rim defect using a retroauricular artery perforator-based island flap. The next year, Kim et al[11] reported successful reconstruction after a resection of malignant eccrine poroma using a retroauricular artery

Table 2

Summary of patients underwent surgery.

Patient No.	Age	Sex	Follow-up time (month)	Cause of postauricular defect	Flap size (cm)	Complication
1	56	F	3	Squamous cell carcinoma	1.5×2	N
2	63	M	11	Seborrheic keratosis	2.1×2.3	N
3	68	F	8	Seborrheic keratosis	2.5×4	N
4	75	F	10	Squamous cell carcinoma	2.1×2.8	N
5	61	F	11	Squamous cell carcinoma	2.4×3.2	N
6	61	M	4	Seborrheic keratosis	2.6×3.4	N
7	68	M	9	Trauma	2×3	N
8	59	M	8	Seborrheic keratosis	2×3.5	N
9	70	F	8	Trauma	3×3.5	Venous congestion
10	60	M	6	Squamous cell carcinoma	2.8×3.4	N
11	62	F	7	Seborrheic keratosis	2.6×3	N
12	70	F	5	Seborrheic keratosis	1.6×2.3	N
13	65	F	12	Basal cell carcinoma	2.5×3.5	Venous congestion
14	60	M	11	Seborrheic keratosis	2.7×3.2	N
Total (average)	64.1		8.0			

F = female, M = male, N = none.

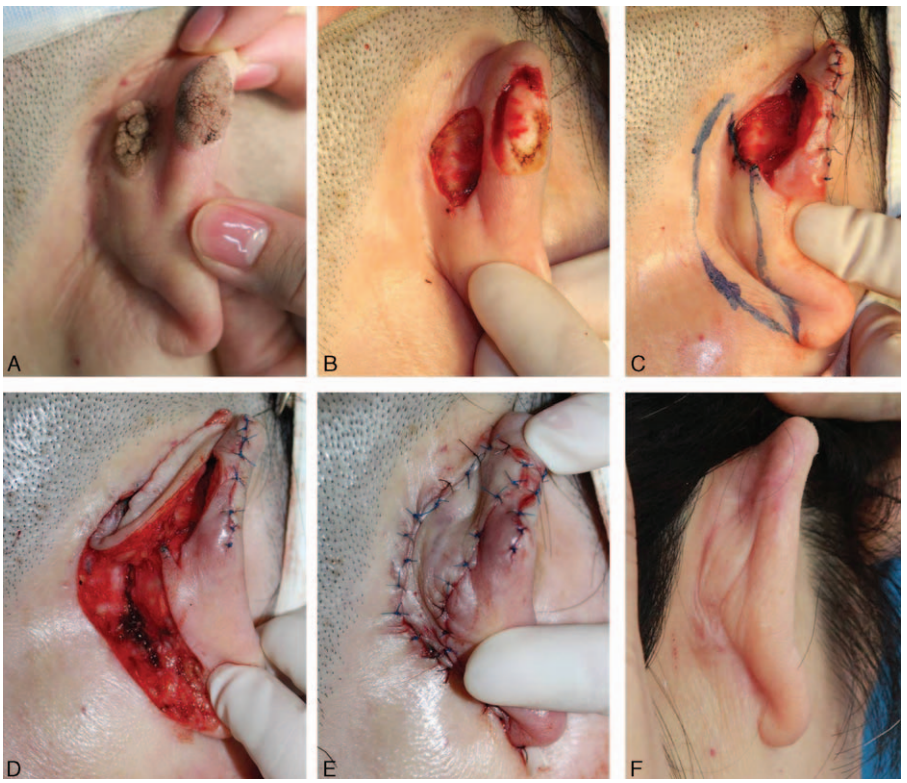

Figure 4. Comparison between preview and postview. (A) Preview. (B) Complete resection. (C) Suture of the defect on the helical rim and design of the Retroauricular Artery Perforator-based Island Flap. (D) Dissected the flap and rotated to the postauricular defect without tension. (E) Suture of the flap to the defect and the donor site directly with drainage setting. (F) Satisfactory result at 1-year follow-up.

perforator-based island flap. Although retroauricular artery perforator-based island flaps have been described in clinical reports, few articles have described the results of cadaver studies that have investigated vascular support.

Our cadaver dissection confirmed that perforators arising from the PAA nourished the posterior auricular surface in all dissections. Previous research on the vascular networks of the retroauricular flap has shown that the auricular anastomoses are found at the upper portion of the posterior surface of the ear, whereas some reticular anastomoses occur between auricular branches derived from the STA and PAA.[12] Shokrollahi et al[13] also reported the presence of anastomoses between the STA and PAA. These researchers also classified the postauricular fascia into 3 layers. The intrinsic postauricular fascia (IPF) is less fibrous and not in direct continuity with any significant muscle bulk except for attachments to the auricularis posterior. The thicker EPF (extrinsic postauricular fascia) is continuous with the mastoid area, and the AFI (auricular fascial incisura) is a demarcation between the IPF and EPF. Our cadaver dissection study showed that the perforators pierced the postauricular fascia and gave rise to 2 or 3 branches of the IPF layer that supplied the retroauricular skin. Although the diameter was smaller than that of most perforators reported in other areas, in our clinical study, the retroauricular perforator supplied skin that ranged in area from 20×15 to 40×30 mm. Surprisingly, the perforator from the occipital artery was also found to nourish the retroauricular skin in a fraction of the investigated cadavers.

The human ear is an important part of the features of the face. Any tissue loss exceeding one-fourth of the vertical auricular size will lead to aesthetic disfigurement requiring repair using similar tissue.[14] The retroauricular skin perfectly matches the post-auricular surface close to the defect in terms of color and texture. Compared to traditional retroauricular flaps, this flap is thinner.[15] In our cases, no patient required a second operation to thin the flap. The design of the pedicle on the flap edge facilitated flap rotation. In some cases, the flap rotation angle may reach 180°, while retaining adequate vascularity. The area of the flap is related to the vessels within the pedicle. We suggest that as much pedicle tissue as possible should be preserved while ensuring that the flap can be adapted to the defect without tension. The largest flap we designed without any distal necrosis had an area of 40×25 mm, and the farthest point to the pedicle was 20 mm. Because the skin in the retroauricular area is relatively relaxed, the donor site can be closed with little tension. The donor site scar is acceptable and can be concealed by hair. All patients were satisfied with the aesthetic and functional outcomes achieved after reconstruction.

During the operation, meticulous dissection is required to avoid traumatizing, stretching, or kinking the perforator artery. If necessary, a magnification loupe can be used. Because the diameter is very small, it is not necessary to visualize the perforator. Based on our experience, the vessel is easily traumatized by perforator dissection. Preoperative Doppler ultrasonography flow imagery is valuable for flap design. Furthermore, observation of reversed flow can be used to confirm safe elevation of the retroauricular artery perforator-based rotating island flap.[16]

Venous congestion was observed during the early postoperative period, but no other vessel-related complications were observed during long-term follow-up. It is believed that venous drainage will

arise from the fibrofatty tissue surrounding the artery, similar to the situation described with digital neurovascular island flaps.[17] It has been reported that a large subcutaneous area of tissue surrounding the pedicle should be preserved to avoid venous congestion.[18] Although no supporting statistical analyses were performed, we observed that adequate preservation of tissue surrounding the perforator was negatively related to the incidence of venous congestion. The branch of the vein likely has the same orientation as the perforator.

5. Conclusions

A retroauricular artery perforator-based island flap is ideal for 1-stage reconstruction of postauricular skin defects. It results in no additional donor site deformity, no need for secondary revision, and acceptable aesthetic results.

References

[1] Youn S, Kim YH, Kim JT, et al. Successful reconstruction of a large helical rim defect using retroauricular artery perforator-based island flap. J Craniofac Surg 2011;22:635–7.
[2] Cordova A, D'Arpa S, Pirrello R, et al. Retroauricular skin: a flaps bank for ear reconstruction. J Plast Reconstr Aesthet Surg 2008;61(suppl 1): S44–51.
[3] Park C, Shin KS, Kang HS, et al. A new arterial flap from the postauricular surface: its anatomic basis and clinical application. Plast Reconstr Surg 1988;82:498–505.
[4] Schonauer F, Vuppalapati G, Marlino S, et al. Versatility of the posterior auricular flap in partial ear reconstruction. Plast Reconstr Surg 2010;126:1213–21.
[5] McInerney NM, Piggott RP, Regan PJ. The trap door flap: a reliable, reproducible method of anterior pinna reconstruction. J Plast Reconstr Aesthet Surg 2013;66:1360–4.
[6] Papadopoulos ON, Karypidis DK, Chrisostomidis CI, et al. One-stage reconstruction of the antihelix and Concha using postauricular island flap. Clin Exp Dermatol 2008;33:647–50.
[7] Selçuk CT, Durgun M, Bozkurt M, et al. The reconstruction of full-thickness ear defects including the helix using the superior pedicle postauricular chondrocutaneous flap. Ann Plast Surg 2014; 72:159–63.
[8] Hu J, Zhang Q, Zhang Y, et al. Partial helix defect repair by use of postauricular advancement flap combined with ipsilateral conchal cartilage graft. J Plast Reconstr Aesthet Surg 2014;67:1045–9.
[9] Cordova A, D'Arpa S, Pirrello R, et al. Retroauricular skin: a flaps bank for ear reconstruction. J Plast Reconstr Aesthet Surg 2008;61(suppl 1): S44–51.
[10] Youn S, Kim YH, Kim JT, et al. Successful reconstruction of a large helical rim defect using retroauricular artery perforator-based island flap. J Craniofac Surg 2011;22:635–7.
[11] Kim WH, Kim JT, Park CK, et al. Successful reconstruction after resection of malignant eccrine poroma using retroauricular artery perforator-based island flap. J Craniofac Surg 2012;23: e579–82.
[12] Yang D, Morris SF. Vascular basis of the retroauricular flap. Ann Plast Surg 1998;40:28–33.
[13] Shokrollahi K, Taylor JP, Le Roux CM, et al. The postauricular fascia: classification, anatomy, and potential surgical applications. Ann Plast Surg 2014;73:92–7.
[14] Ghassemi A, Modabber A, Talebzadeh M, et al. Surgical management of auricular defect depending on the size, location, and tissue involved. J Oral Maxillofac Surg 2013;71:e232–42.
[15] Butler CE. Extended retroauricular advancement flap reconstruction of a full-thickness auricular defect including posteromedial and retroauricular skin. Ann Plast Surg 2002;49:317–21.
[16] Kobayashi S, Nagase T, Ohmori K. Colour Doppler flow imaging of postauricular arteries and veins. Br J Plast Surg 1997;50:172–5.
[17] Hofer SO, Posch NA, Smit X. The facial artery perforator flap for reconstruction of perioral defects. Plast Reconstr Surg 2005;115: 996e1003.
[18] Yotsuyanagi T, Watanabe Y, Yamashita K, et al. Retroauricular flap: its clinical application and safety. Br J Plast Surg 2001;54:12–9.