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ORIGINAL PAPER

Propeller flaps in partial ear reconstruction: a case series

Fabrizio Schonauer[1] · Annachiara Cavaliere[1] · Giuseppe Pezone[1] · Carolina Pollio[1] · Francesco D'Andrea[1]

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Abstract

Background Ear defect reconstruction still remains a surgical challenge today. Proper reconstruction should result in correction of the deformity with minimum morbidity with the aim of achieving the most esthetically pleasing outcome possible. Herein, we present our clinical experience with propeller flap reconstruction of external ear defects with a focus on indications and surgical technique.

Methods Fourteen patients underwent surgery at our Plastic Surgery Unit between January 2015 and October 2019. After identifying perforators with a handheld Doppler ultrasound, a tailor-made flap was designed for each patient. Following tumor excision, dissection of the pedicle and of the remaining flap was performed with the aid of surgical loops. Flap in-setting and donor site closure were final steps.

Results Flaps have survived in their entirety in almost all our patients (13/14) maintaining optimal color and elasticity and showing no complications. In one case, a superficial distal necrosis was observed and, in another patient, tumor recurrence took place.

Conclusions Propeller flaps offer great advantages when used in ear reconstruction ensuring excellent esthetic results with a one-stage technique. Nevertheless, it must be kept in mind that good dissection skills are required in order to avoid complications.

Level of evidence: Level IV, Therapeutic study.

Keywords Propeller flap · Ear reconstruction · Postauricular flap · Post-oncologic · Auricular defect

Introduction

Reconstruction of partial ear defects can be performed in different ways depending on the location, size, and type of lesion. A good reconstruction should aim for correction of the deformity with minimum morbidity and achievement of an utmost natural esthetic outcome.

Postauricular skin for ear reconstruction has previously been given attention by various authors because of its rich vascularization, ease of surgical access, and reduced donor site morbidity. For these reasons, it is considered an ideal donor site for ear reconstruction [1, 2]. Over time, the preauricular region has also been recognized as an ideal donor site for both small- and moderate-sized ear defect reconstruction [3, 4].

A propeller flap is defined as an "island flap that reaches the recipient site through an axial rotation" [5], whereas an island flap that reaches the recipient site with an advancement of movement or a flap that is not completely islanded is not included in the definition of a propeller flap [5].

Despite the fact that the term "propeller" was first applied to "flap" movement by Hyakusoku in 1991 [6] in describing the use of a 90° rotated subcutaneous pedicle flap for release of burn scars, a great contribution to the standardization and popularization of the propeller flap technique was made by Mr. TC Teo, particularly so in Europe [7, 8]. Since then, several authors have described the use of these flaps in different regions of the body reporting satisfactory results [9]. However, so far little relevance has been given to the use of propeller flaps in the treatment of partial ear defects.

The purpose of our study is to bring to light the advantages of harvesting propeller flaps based upon different perforators and use them for auricular defect reconstruction. Herein, we report 14 cases of auricular reconstruction using

✉ Fabrizio Schonauer
fschona@libero.it

[1] Unit of Plastic Surgery, University "Federico II", Naples, Italy

propeller flaps based on both the postauricular and preauricular perforators.

Patients and methods

Fourteen patients (10 male and 4 female) aged from 18 to 71 years presenting partial ear defects underwent surgery between January 2015 and October 2019 at our Plastic Surgery Unit. Patients' defects were secondary to elective excision of skin lesions. Lesions were excised according to oncologic guidelines. All patients gave their signed informed consent prior to surgery. During the planning stage, the resection margins were designed according to the lesion to be removed. A hand-held Doppler ultrasound was then used to identify the location of potential perforators of the posterior auricular artery (PAA) or of the superficial temporal artery (STA). The PAA ascends through the groove between the auricular cartilage and mastoid, giving rise to three perforators which can be identified in correspondence of the upper, the middle, and the lower third of the ear [10]. Anteriorly to the ear STA usually gives rise to two perforators, one pierces the parotid gland and reaches the tragal region, while the other can be found proximal to the radix of the helix [11]. The STA perforator flap used in our preauricular propeller flap was based on this latter perforator.

Skin islands were designed elliptical (mostly long ellipse) with the perforator centered on one of the eccentric one-fifth of the flap. The flap skin paddle size was marked in consideration of (1) the measured template of the expected defect, (2) the perforator position, (3) possible flap movement, and (4) the farthest confines of the defect (maximum reach) (Fig. 1).

Surgery was performed under magnification with 3.5 × surgical loupes. Dopplered perforating vessels were examined through an exploratory incision made along the margin of the flap outline. The skeletonization of the perforator was performed "a la demand," moving the flap to test the reach [12]. The more the vessel was dissected and freed from its connection with the surrounding tissue, the more the flap gained movement with reduced risk of kinking [7, 8, 13] (Fig. 2). For postauricular propeller flaps, to transfer the flap from the posterior to the anterior part of the ear or to the external meatus area, a cartilage window, obtained after lesion excision, was usually used. No flap portion was de-epithelialized.

In case of a 180° flap rotation, the safer sense of rotation was opted for by gently rotating the flap first counterclockwise and then clockwise to evaluate flap perfusion before in-setting the flap [14]. Lastly, once final hemostasis was achieved with bipolar cautery, the flap was moved to the defect and sutured in place with 6/0 Ethilon.

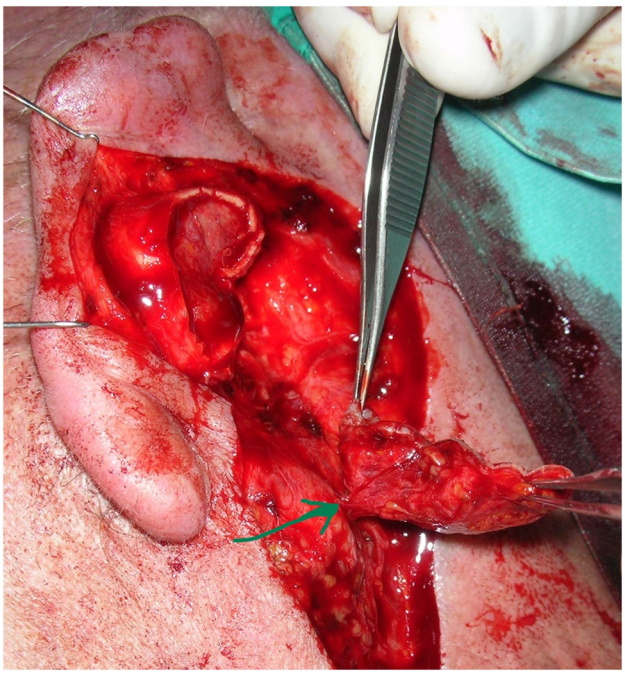

Fig. 2 Intraoperative view of postauricular perforator skeletonization (green arrow)

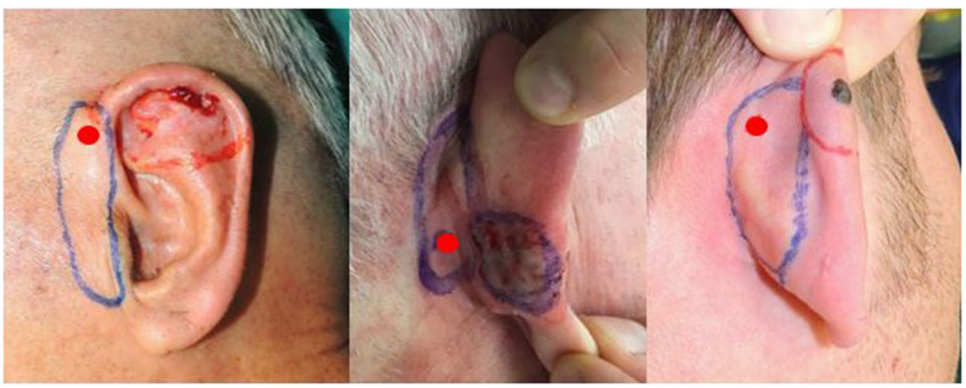

Fig. 1 Perforator position in different auricular propeller flaps

Results

Surgery was performed under local anesthesia by infiltration of mepivacaine with adrenaline 1:100,000 in 12 patients, while in 2 patients (external acoustic meatus defect reconstruction), surgery was performed under general anesthesia. Auricular defects were most commonly caused by basal cell carcinoma excision ($n=11$, 78.6%). Melanoma accounted for 21.4% of cases ($n=3$). Flap size ranged from 1.4 cm × 1.5 cm to 4 cm × 3 cm. Auricular defects were mostly localized on the upper part of the helix, followed by the middle part of the helix and the external auditory canal. For helical reconstruction, an upper posterior perforator was chosen with a posterior skin island; for conchal and external auditory canal reconstruction, a low posterior perforator was preferred with a lower skin island; for a large anterior auricular defect, we have used a preauricular skin island with a cranial perforator.

A total of 13 defects were reconstructed with a postauricular flap (92.8%) and one with a preauricular flap (7.2%). In this patient, a more complex upper pole ear reconstruction was proposed; nevertheless, the patient opted for an easier option. Regarding pedicle rotation, the propeller flap rotation arc ranged from 55 to 180°. The propeller flap survived completely in 13 out of 14 patients while one flap resulted in superficial distal necrosis which was treated conservatively. Flaps maintained good color and elasticity over time. Resection margins were tumor-free in all cases but one. Basal cell carcinoma local recurrence was found in a male patient at the external acoustic meatus site. The other 13 recurrence-free patients were satisfied with the esthetic results obtained. Results are summarized in Table 1.

Three representative cases are presented in Figs. 3, 4, and 5, demonstrating two examples of postauricular propeller flap and one case of preauricular propeller flap.

Discussion

Reconstruction of ear defects has always been a challenge to the plastic surgeon given the complex three-dimensional conformation of this organ. The preauricular region can be considered a favorable site for the harvesting of pedicled and island flaps to reconstruct the anterior surface of the ear [3, 4]. Postauricular skin has always been noted for facial reconstruction because of its optimal vascularization, skin laxity, and skin color which is similar to that of the external ear. These three reasons make it an ideal donor site for ear reconstruction [1, 2]. Postauricular flap technique has been thoroughly described for the reconstruction of various ear defects, including for those of the anterior surface [1, 2].

Table 1 Details of patients who underwent ear propeller flap reconstruction

Sex	Age	Etiology	Defect site	Defect size	Flap	Rot. angle	Movement	Complication
M	65	Rodent ulcer (BCC)	Postauricular	3.2 × 2.9 cm	Postauricular	180°	Postauricular to postauricular	None
M	67	BCC	Helical root	1.4 × 1.5 cm	Postauricular	170°	Upper postauricular to upper anterior	None
M	71	Nodular BCC	Upper third retroauricular	3.5 × 2.5 cm	Postauricular	90°	Postauricular to retroauricular	None
F	43	Nodular BCC	Upper helical rim	2.2 × 1.9	Postauricular	90°	Postauricular to rim	Distal 0.7 cm necrosis
M	64	BCC	Upper anterior helical rim	1.8 × 1.5 cm	Postauricular	160°	Upper postauricular to upper anterior	None
F	65	BCC	Ext acoustic meatus (EAM)	2.9 × 3.3 cm	Postauricular	80°	Postauricular to anterior (EAM)	None
M	69	BCC	Retroauricular	2.8 × 2.7 cm	Postauricular	90°	Postauricular to retroauricular	None
M	63	BCC	Ext acoustic meatus (EAM)	3.4 × 2.9 cm	Postauricular	70°	Postauricular to anterior (EAM)	6 months recurrence
M	57	Melanoma in situ	Upper helical rim	1.8 × 1.9 cm	Postauricular	80°	Posterior to upper rim	None
M	65	Nodular BCC	Middle helical rim	2.4 × 2.6 cm	Postauricular	70°	Postauricular to rim	None
F	53	Nodular BCC	Tragus + EAM	3 × 2.8 cm	Postauricular	70°	Postauricular to anterior (EAM)	None
F	18	Melanoma in situ	Upper helical rim	2 × 2 cm	Postauricular	100°	Postauricular to middle rim	None
M	32	Melanoma	Helical rim	2.8 × 2.8 cm	Postauricular	90°	Postauricular to rim	None
M	62	Infiltrating BCC	Upper pole	4 × 3 cm	Preauricular	55°	Prearicular to anterior upper ear	None

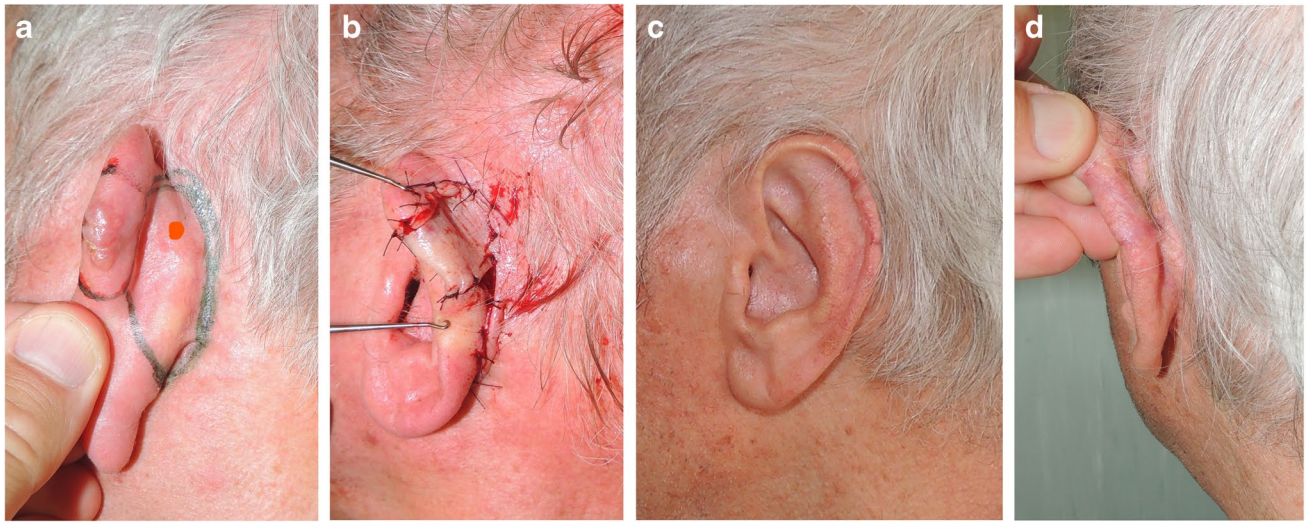

Fig. 3 **A** Nodular basal cell carcinoma of the helix and postauricular propeller flap design. **B** Postauricular propeller flap has been rotated 75° to the helical defect. **C** Nine months follow-up. **D** Postauricular donor site scar

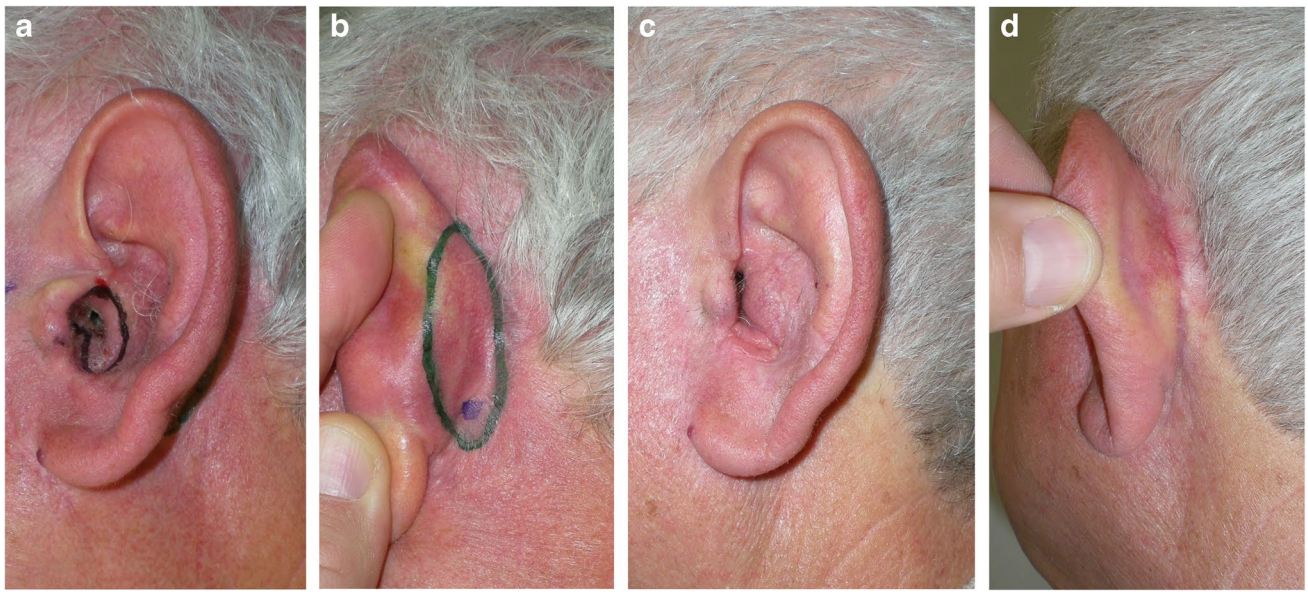

Fig. 4 **A** Basal cell carcinoma of the external acoustic meatus. **B** Planning of the postauricular propeller flap and perforator position. **C** Six months follow-up after reconstruction. **D** Donor site postoperative outcome

Despite this, little emphasis has been given to the advantages of propeller flaps for partial ear reconstruction.

Our group first reported on three cases of posterior auricular propeller flaps for reconstruction of the anterior helical root back in 2010 [1]. In their series of 85 Freestyle Pedicled Perforator Flaps, D'Arpa et al. reported on a 180° propeller flap taken from the posterior auricular area to reconstruct a retro-auricular skin defect [9]. More recently, a series of retro-auricular artery perforator-based propeller flaps has been reported for the reconstruction of large ear defects [15].

Our experience in this series of 14 new cases of propeller flap transfer to the external ear has further proven this technique to be a useful reconstructive tool giving good cosmetic and functional results in different areas of the ear. Attention must be given to the degrees of rotation depending on the relative position of the perforating vessel and the soft tissue defect. Considering the extra small size of perforators, dissection should be carried out under a 3.5 × loupe magnification. The laxity of the pre and postauricular skin allows for the direct closure of the donor site without excessive tension.

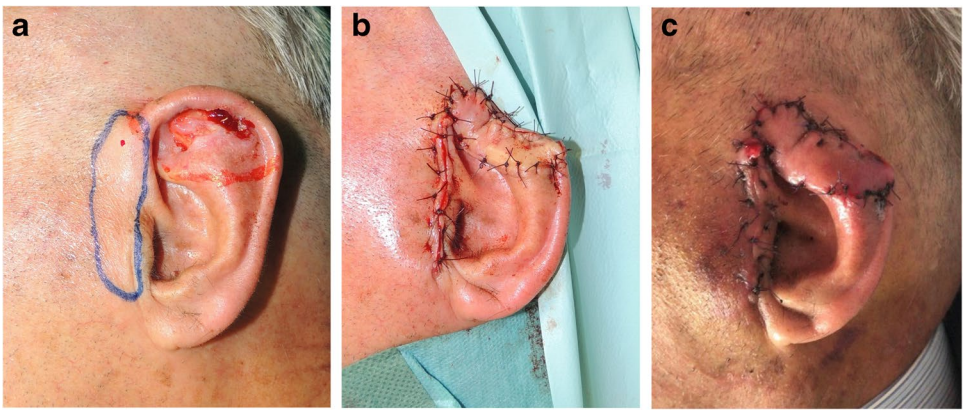

Fig. 5 **A** Basal cell carcinoma of the left upper third; after patient's refusal of a full thickness reconstruction with rib cartilage, a preauricular propeller flap was planned with perforator marking. **B** Propeller flap transfer. **C** Ten days postoperative result

Propeller flap movement from the posterior auricular area to the external acoustic meatus defect requires particular attention because it is a tridimensional movement rather than a standard bidimensional rotation. This movement is favored by the position of the posterior perforator that can be sufficiently low in the postauricular area to reach the acoustic meatus through a full thickness window, thus a precise planning under this tridimensional movement is mandatory.

In conclusion, based upon our favorable experience, we can conclude that propeller flaps represent a valid alternative for reconstruction of partial ear defects allowing for the obtainment of optimal esthetic results.

Propeller flaps have proved to be very reliable with low risk of failure. Their movement allows to reach skin defects in a more convenient way compared to standard random skin flaps.

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Declarations

Ethics approval This is an observational study. The Federico II University of Naples Research Ethics Committee has confirmed that no ethical approval is required.

Patient consent Informed consent was obtained from all individual participants included in the study.

Conflict of interest Fabrizio Schonauer, Annachiara Cavaliere, Giuseppe Pezone, Carolina Pollio, and Francesco D'Andrea declare no competing interests.

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