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ORIGINAL PAPER

Freestyle local perforator flaps for facial reconstruction: clinical experience and complications

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Abstract
Background Reconstruction of facial defects always represents a surgical challenge as functional and cosmetic outcomes must be taken into account more than any region of the body. The concept of freestyle perforator flaps has been developed to obtain a complete range of freedom in their movement to reach the defect. We present our clinical experience with facial perforator flaps, focusing on indications, surgical technique, and complications.
Methods Thirty-one facial defects were reconstructed with freestyle local perforator flaps between January 2007 and November 2014. Doppler identification of perforator vessels preceded preoperative planning and the flap harvesting followed the dissection of perforator vessels.
Results Twenty-two clinical cases had no complications. Four had venous congestion that resolved spontaneously, three had a distal 1/3 superficial necrosis, one suffered hematoma, and one had a 1/5 distal area of full thickness necrosis.
Conclusions Freestyle perforator approach was applied to gain more freedom for facial reconstruction, allowing one-stage procedures and low donor site morbidity. Good anatomical understanding, precise planning, and meticulous technique can affect clinical results of perforator flaps in the face. A critical approach is essential to get better results.
Level of Evidence: Level IV, therapeutic study.

Keywords Facial reconstruction · Freestyle approach · Perforator flap

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Introduction

Reconstruction of facial defects always represents a surgical challenge as functional and cosmetic outcomes must be taken into account more than in any other region of the body. Local facial flaps constitute an excellent reconstructive option because of the optimal color and texture match of their tissues. The excellent vascularity of facial skin ensures a reliable blood supply to pedicled or islanded local flaps.

Nevertheless, local flaps have not a complete range of freedom in their movement to reach the defect. Moreover, cutaneous or subcutaneous pedicled flaps can sometimes require two-time surgery with further revisions in order to obtain good results.

The freestyle approach, introduced by Mardini and Wei in 2004 [1], was first reported by Hofer [2] for facial reconstruction. Freestyle perforator flaps can be harvested based on the preoperative evaluation of Doppler signals in a specific region [1–3].

Thanks to their thin pedicle, which allows a large arc of rotation, these flaps have least restriction of movement and

can easily reach different shaped defects around the face. They can be used to replace tissues for small to medium size facial defects of various origins [4], considering that flap dimension can be limited by primary closure of harvesting site and pedicle location [5]. In the literature, it has been reported a maximum facial perforator flap size of 9 × 5 cm [3].

Moreover, they can be performed in a single-stage procedure and therefore, surgical timing is optimized with esthetically pleasing results and low donor site morbidity.

Cadaveric studies on perforator arteries were first carried out by Taylor et al. [6] On one hand, facial arteries have been recently studied too and many perforator vessels have been described in the face [2, 7, 8]. On the other hand, clinical series dealing with the use of local perforator flaps for reconstruction of facial defects are not so numerous in literature.

For this reason, clinical applications for facial perforator flaps have not been extensive investigated yet. Surgical advantages of local perforator flaps have been well described [4, 9, 10] but not so much has been said about complications. The aim of this study is to present our clinical experience with reconstruction of small to medium size post-oncological defect of the face using local perforator flaps, focusing on indications, surgical technique, and complications.

Patients and methods

Thirty-one facial post-oncological defects were reconstructed with freestyle local perforator flaps between January 2007 and November 2014 at the Plastic Surgery Unit of University "Federico II" of Naples. Patients were aged between 29 and 84 years (mean 62), 18 male and 13 female patients.

Sixteen flaps were based on perforators of the facial artery at the nasolabial region, 2 flaps were harvested in the postauricular region, 3 in the submental area, 8 in the perizygomatic area for lower eyelid reconstruction. Beside these, 2 flaps were harvested on the supra-trochlear artery and vein itself [12], but in a perforator fashion. These two patients are included in this series because the technical procedure was the same of a perforator flap.

In terms of flap shape, 21 were propeller flaps, 7 were V-Y type, and 3 were perforator based bilobed flaps. The arc of rotation of the propeller flaps ranged from 90 to 180 degrees.

In terms of pedicle dissection, perforator vessels were identified and preserved in the dissection in 14 cases, without attempting skeletonization. In the other 17 cases, the pedicle was more aggressively prepared according to the need of more movement freedom.

Patients' characteristics are resumed in Table 1.

Our freestyle method could be divided into two steps: planning and surgery.

Table 1 Patient characteristics

Patient charateristics		*N*°
Sex (%)	M	18 (60 %)
	F	13 (40 %)
Age	Median	62
	Range	29–84
Tumor diameter	Median	3.1 cm
	Range	2.3–5.5 cm
Flap shape	Propeller	21 (67.74 %)
	V-Y	7 (22.58 %)
	Bilobed	3 (9.67 %)
Source artery	Facial artery perforator	16 (51.61 %)
	Posterior auricular artery perforator	2 (6.45 %)
	Submental branch of facial artery perforator	3 (9.68 %)
	Peri-zigomatic area perforator	8 (25.8 %)
	Suprethroclear artery and vein (perforator-like flaps)	2 (6.45 %)
Skeletonization	Partial	14 (45.16 %)
	Complete	17 (54.83 %)

In planning, we drew the excision margins and established the expected defect, then we Dopplered the perforator vessels coming from the axial arteries around the defect site. One or more suitable perforators were chosen among the Dopplered ones and the potential flap was designed according to the reconstructive needing and the possible flap movement. Perforator flaps, unlike pedicled or islanded flaps, enable great freedom of movement and up to 180 degrees rotation is possible in a propeller fashion. The safer sense of rotation was chosen in 180° rotation by gently rotating the flap first counterclockwise and then clockwise to evaluate flap perfusion, before the insetting of the flap [13].

At surgery, we made an exploratory incision at the flap margin to visualize perforator's position and caliber. In this way, we checked the presence of the dopplered perforator before carrying on the rest of the flap dissection. Therefore, the best perforator was chosen according to the flap characteristics. We preserved and included the vessel in the flap dissection while skeletonization of the perforator was realized "a la demand" once the flap had been moved to see if or not it reaches the defect. The more the vessel was skeletonized and freed from the connections with the tissues around the sierosa, the more the flap gained in terms of movement with the reduction of kinking risk. Finally, the flap was moved to the defect and the inset is realized. Surgery was performed under local anesthesia in 29 patients, while in 2 patients surgery was combined with complex procedures and therefore performed under general anesthesia.

Table 2 Results

Results		*N*°
Histological type	BCC	16 (51.6 %)
	SCC	14 (45.1 %)
	Melanoma	1 (3.2 %)
Follow-up	Range	4–37 months
Complications (25 %)	Venous congestion	4 (12.9 %)
	Superficial necrosis	3 (9.68 %)
	Full thickness necrosis	1 (3.22 %)
	Pedicle compression	1 (3.22 %)

Results

Histology revealed 16 basal cell carcinomas, 14 squamous cell carcinomas, and 1 melanoma. No tumor recurrence was observed during the follow-up period. Twenty-two flaps survived without complications (75 %), while 9 cases presented minor complications (25 %) and they were all propeller-type flaps. In particular, 4180° propeller flaps had temporary venous congestion which resolved spontaneously in 2–3 days; 3 propeller flaps experienced superficial necrosis in the distal 1/3, while a full thickness necrosis of the distal 1/5 was observed in one flap: these patients were treated conservatively with vaseline gauze dressings twice weekly for 2 weeks. One 180° propeller flap suffered pedicle compression by a haematoma; therefore, an additional surgical intervention was performed to evacuate haematoma, excise ¼ distal of the flap, and readvance it to cover the defect (Table 2).

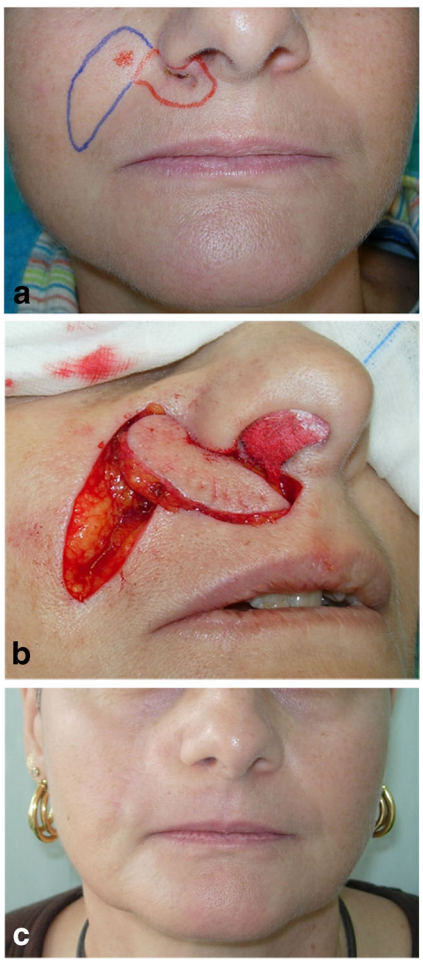

Fig. 1 **a** A 48-year-old woman with a basal cell carcinoma on the right nasal flare and design of the flap. **b** 90° propeller facial artery perforator flap dissection after tumor resection. **c** A 2-year follow-up result

Fig. 2 **a** Basal cell carcinoma of the lateral canthus in a 72-year-old man and design of a 140° propeller peri-zygomatic perforator flap. **b** Immediate post-operative result. **c** A 1-year follow-up result

Representative cases are depicted in Figs. 1a–c, 2a–c, 3a–c, and 4a–c.

Discussion

In 1989, Koshima described for the first time a "perforator flap" [14] and since then perforator flaps have gained ever-increasing popularity in reconstructive surgery. According to the "Gent" consensus [15], a "perforating vessel," even known as "perforator," has its origin in one of the axial vessels of the body and passes through different structures, perforating the deep fascia before reaching the skin. Different kind of perforators has been described according to their anatomical features. D'Arpa et al. [11] have emphasized that facial artery perforators actually pierce the superficial muscoloaponeurotic system layer as there is no deep fascia in the face. Anatomy of facial artery perforators has been evaluated in different cadaver studies [2–8] (Table 3).

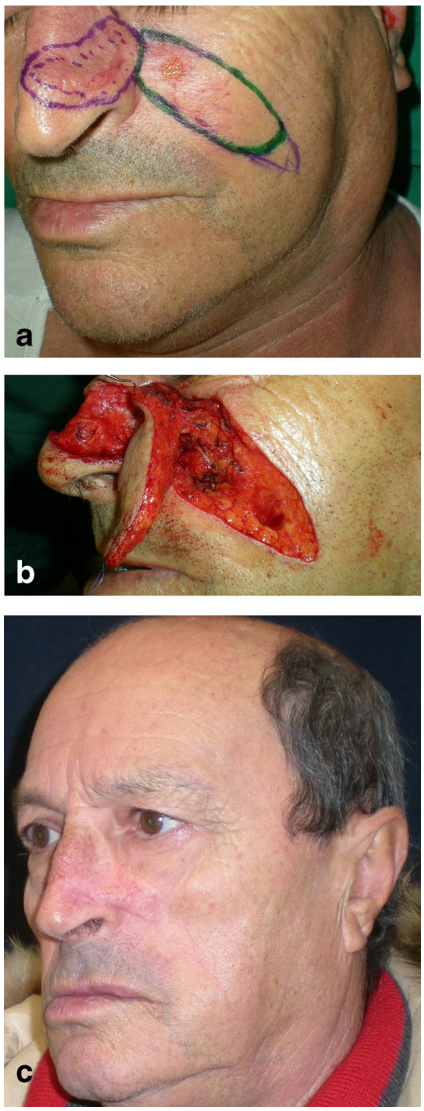

Fig. 3 **a** Extended basal cell carcinoma of the nose in a 68-year-old man and design of a 160° propeller facial artery perforator flap. **b** Intraoperative detail of FAP flap. **c** A 20-month follow-up result

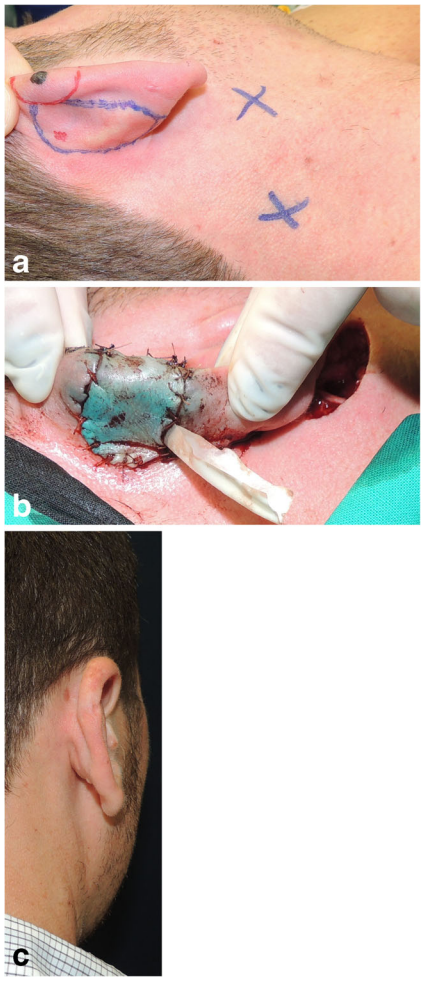

Fig. 4 **a** Melanoma of the ear in a 28-year-old man and design of a 90° posterior auricular artery perforator flap. **b** Immediate post-operative result. **c** A 33-month follow-up result

Handheld Doppler identification of perforator vessels was always the first step in our freestyle approach as a prerequisite to determine the flap design. This is in line with the advantages of using color Doppler ultrasound to localize facial artery perforators, recently reported by Gunnarson et al. [3]. On the other hand, according to other authors [4, 10, 11, 14–17], adequate localization of suitable perforator vessels in the face cannot be guaranteed by Doppler in even the best hands due to the anatomical features of these region. Axial arteries of the face are in fact sometimes really superficial so that their Doppler signal can be confused with that coming from the perforators. However, our experience has lead us to rely on the use of Doppler for planning perforator flaps of the face because of the high rate of accordance among Dopplered position and dissection of perforator vessels.

It has been shown that single perforators supply large areas of tissue in other parts of the body. Freestyle perforator flaps

Table 3 Anatomy of facial artery perforators

	Average number of facial artery perforators per hemiface	Mean diameter of facial artery perforators at their origin on the facial artery	Mean length of facial artery perforators
Hofer et al. [2]	5.7 ± 1.8	1.2 ± 0.3 mm	25.2 ± 9.5 mm
Ng et al. [7]	4 ± 2	0.94 ± 0.29 mm	14.12 ± 3.46 mm
Qassemyar et al. [8]	506 ± 0.86	0.96 ± 0.21 mm	–

can be based on one or more perforators obtaining a reliable blood supply together with great versatility in design, free choice of orientation, arc of rotation up to 180°, wider range of motion compared with local flaps, and primary closure of the donor site along the relaxed skin tension lines to minimize any adverse scarring. These kind of flaps, based on an identified perforator from a known source axial vessel of the face, can be realized in different areas such as nasolabial sulcus, peri-oral, peri-zygomatic, and submental region [2–15]. During dissection, it is necessary to leave a gentle cuff of subcutaneous fatty tissue around the artery to help drainage in respect of avoiding pedicle kinking. We stress the

Table 4 Patient charateristics II

Number	Sex	Age	Pathology	Flap shape	Movement	Source artery	Risk factors	Complications
1	M	29	MM	Propeller	Rotation 90°	PAAP	–	–
2	M	36	BCC	Propeller	Rotation 90°	ST	–	–
3	M	42	SCC	Propeller	Rotation 120 °	SB	–	–
4	M	56	SCC	Propeller	Rotation 140°	SB	H	–
5	M	58	SCC	Propeller	Rotation 180°	FAP	S	Venous congestion
6	M	68	SCC	Propeller	Rotation 90 °	PAAP	S	–
7	M	68	BCC	Propeller	Rotation 160°	FAP	H	–
8	M	67	SCC	Bilobed	Transposition	FAP	RT	Distal full thickness necrosis
9	M	72	BCC	Propeller	Rotation 140°	PZP	–	–
10	M	73	SCC	V-Y	Advancement	FAP	D	–
11	M	78	BCC	Propeller	Rotation 180°	PZP	S	Venous congestion
12	M	80	BCC	V-Y	Advancement	FAP	–	–
13	M	84	SCC	V-Y	Advancement	FAP	H	–
14	M	77	SCC	V-Y	Advancement	FAP	–	–
15	M	62	BCC	Propeller 180°	Rotation 180°	FAP	D	Venous congestion
16	M	63	SCC	Propeller 160°	Rotation 160°	FAP	RT	Superficial necrosis
17	M	74	SCC	Bilobed	Transposition	FAP	–	–
18	M	67	BCC	Propeller	Rotation 180°	PZP	D	Pedicle compression
19	F	57	SCC	Propeller	Rotation 120°	SB	–	–
20	F	59	BCC	Propeller	Rotation 90°	ST	H	–
21	F	61	BCC	Propeller	Rotation 180°	PZP	S	Venous congestion
22	F	37	BCC	Propeller	Rotation 120°	PZP	–	–
23	F	36	BCC	Propeller	Rotation 120°	PZP	S	–
24	F	80	SCC	V-Y	Advancement	FAP	H	–
25	F	48	BCC	Propeller	Rotation 90°	FAP	–	–
26	F	57	BCC	V-Y	Advancement	FAP	–	
27	F	65	SCC	Bilobed	Transposition	FAP	D	–
28	F	65	BCC	Propeller	Rotation 140°	PZP	S	Superficial necrosis
29	F	63	SCC	V-Y	Advancement	FAP	–	–
30	F	68	BCC	Propeller	Rotation 160°	FAP	–	–
31	F	72	BCC	Propeller	Rotation 160 °	PZP	D	Superfical necrosis

MM malignant melanoma, *BCC* basal cell carcinoma, *SCC* squamous cell carcinoma, *FAP* facial artery perforator, *PZP* peri-zygomatic area perforator, *SB* submental branch of facial artery perforator, *PAAP* posterior auricular artery perforator, *S* smoke, *D* diabetes, *H* Hypertension, *RT* radiation therapy

importance of choosing the safer sense of rotation in 180° propeller flap by rotating the flap both clockwise and counter-clockwise before insetting [13].

We observed that 44.4 % of complications developed in smokers, 33.3 % in diabetics, and 22.2 % in patients who received prior radiotherapy (Table 4). We suggest to accurately select patients and identify possible risk factors which can lead to complications such as diabetes, smoke, radiation, and immune-suppression [18].

In conclusion, freestyle local perforator flaps are useful to reconstruct complex facial defects and thanks to their versatility, wide arc of rotation, similar texture, and color match with pleasing results.

Compliance with ethical standards

Conflict of interest Mariagrazia Moio, Gisella Nele, and Fabrizio Schönauer declare that they have no conflict of interest.

Patient consent Patients provided written consent before their inclusion in this study. Additional consent was obtained for the use of their images.

Ethical standards For this type of retrospective study formal consent from a local ethics committee is not required.

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References

1. Wei FC, Mardini S (2004) Free-style free flaps. Plast Reconstr Surg 114(4):910–916
2. Hofer SO, Posch NA, Smit X (2005) The facial artery perforator flap for reconstruction of perioral defects. Plast Reconstr Surg Glob Open 115(4):996–1003 discussion 1004-5
3. Gunnarsson GL, Thomsen JB (2016) The versatile modiolus perforator flap. PRS GO 4(3):e661
4. Gunnarsson GL, Jackson IT, Thomsen JB (2014) Freestyle facial perforator flaps—a safe reconstructive option for moderate-sized facial defects. Eur J Plast Surg 37:315–318
5. Lee JY, Kim JM, Kwon H, Jung SN, Shim HS, Kim SW (2015) Freestyle local perforator flaps for facial reconstruction. Biomed Res Int. 707065
6. Taylor GI, Palmer JH (1987) The vascular territories (angiosomes) of the body: experimental study and clinical applications. Br J Plast Surg 40(2):113–141
7. Ng ZY, Fogg QA, Shoaib TJ (2010) Where to find facial artery perforators: a reference point. J Plast Reconstr Aesthet Surg 63(12):2046–2051
8. Qassemyar Q, Havet E, Sinna R (2012) Vascular basis of the facial artery perforator flap: analysis of 101 perforator territories. Plast Reconstr Surg 129(2):421–429
9. Krijgh DD, Mureau MA (2012) Aesthetic and functional outcome following perioral defect reconstruction using the facial artery perforator flap. J Reconstr Microsurg 28(8):529–538
10. Ruiz-Moya A, Lagares-Borrego A, Infante-Cossío P (2015) Propeller facial artery perforator flap as first reconstructive option for nasolabial and perinasal complex defects. J Plast Reconstr Aesthet Surg 68(4):457–463
11. D'Arpa S, Cordova A, Pirrello R, Moschella F (2009) One-stage reconstruction of the nasal ala: the free-style nasolabial perforator flap. Plast Reconstr Surg 123(2):65e–66e
12. Schonauer F, Taglialatela Scafati S, Molea G (2010) Supratrochlear artery based V-Y flap for partial eyebrow reconstruction. J Plast Reconstr Aesthet Surg 63(8):1391–1392
13. Schonauer F, La Rusca I, Di Monta G, Molea G (2008) Choosing the correct sense of rotation in 180° propeller flaps. J Plast Reconstruct Aesthet Surg 61(12):1492
14. Koshima I, Soeda S (1989) Inferior epigastric artery skin flaps without rectus abdominis muscle. Br J Plast Surg 42(6):645–648
15. Blondeel PN, Van Landuyt KH, Monstrey SJ, Hamdi M, et al. (2003) The "Gent" consensus on perforator flap terminology: preliminary definitions. Plast Reconstr Surg 112(5):1378–1383
16. Thornton JF, Reece EM (2008) Submental pedicled perforator flap: V-Y advancement for chin reconstruction. Plast Reconstr Surg 122(2):468–470
17. Demirseren ME, Afandiyev K, Ceran C (2009) Reconstruction of the perioral and perinasal defects with facial artery perforator flaps. J Plast Reconstr Aesthet Surg 62(12):1616–1620
18. Woodard CR (2013) Complications in facial flap surgery. Facial Plast Surg Clin North Am 21(4):599–604