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Primary and secondary perforator-based flap-in-flap reconstructions of postexcisional head and neck soft tissue defects

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ABSTRACT

Introduction: Perforator-based flap-in-flap (PBFIF) refers to the construct of one flap within another based on a perforator. Primary flap-in-flap is the simultaneous construct of two flaps, one within the other. It is particularly useful in cases where despite perfect planning, the flap does not fit congruently into recesses of the defect. It facilitates tension-free flap inset without the need for secondary movement from adjacent areas. Secondary flap-in-flap is the construction of a flap within a previously transferred settled flap. It is particularly useful in cases of wound dehiscence and partial necrosis, which results in a defect-warranting flap cover, when other flap options are either not feasible or other options have been exhausted.

Aim: To assess the outcome and define the biogeometry of primary and secondary PBFIFs, which were used in postexcisional head and neck soft tissue defects.

Materials and Methods: Eight patients who underwent flap-in-flap head and neck reconstruction from January 2014 to January 2016 (four cases of primary PBFIF with nasolabial flaps, and four cases of secondary PBFIF with pectoralis major myocutaneous flaps) were retrospectively studied. All were nonsmokers with no associated

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comorbidities. At the end of the follow-up period, two independent observers and the patient assessed the outcome based on the Institutional Reconstruction Assessment Score (IRAS).

Results: All flaps settled well with a mean follow-up of 16.75 months. All flaps were used for the reconstruction of postexcisional defects only. None of the patients had any loco regional recurrences. The mean IRAS obtained in 8 patients was 3.5 (primary PBFIF=3.87 and secondary PBFIF= 3.12). None of the flaps resulted in the late distortion of adjacent anatomical landmarks by hypertrophy or contracture of scars.

Conclusion: Flap-in-flap reconstruction (whether primary or secondary) is a useful technique to cover defects where reconstruction without anatomical distortion is required (e.g., face). It is a useful option for a tension-free flap inset. Flap-in-flap reconstruction is a relatively easy adjunct in the salvage reconstructive armamentarium of plastic surgeons.

Background and Introduction

Better understanding of the vascular anatomy of skin[1-11] particularly angiosomes[12] and more recently perforosomes[13,14] has allowed the design of many flap variants. Many flaps are the conglomeration of multiple perforasomes, which are connected to one another through direct and indirect linking vessels[15]. The architecture of the cutaneous vasculature has an impact on the design, construction, and transfer of flaps. Considering the complex composition, primary movements and blood flow pattern of flaps, Converse[16] stated, “there is no simple and all-encompassing system which is suitable for classifying skin flaps.”

“Perforator Based Flap-in-Flap” (PBFIF) refers to the construct of one flap within another based on the perforator from the same source vessel. Primary flap-in-flap is the simultaneous construct of two flaps, one within the other. It is particularly useful in cases where despite perfect planning, the flap does not fit congruently into the recesses of a defect. It facilitates tension-free flap inset with the freedom of mobility without the need for secondary movement from adjacent areas. Secondary flap-in-flap is the construct of a flap within a previously transferred settled flap. It is particularly useful in cases of wound dehiscence and partial flap necrosis that results in a defect-warranting flap cover, particularly when other flap options are either not feasible or have been exhausted.

The random pattern subcutaneous pedicled flap-in-flap was first described by Aoki et al[17] in 2006. This article describes the biogeometry, approach, and applicability of PBFIF variants.

Aim

To assess the outcome and define the biogeometry of primary and secondary PBFIFs reconstructions in the postexcisional head and neck soft tissue defects.

Materials and Methods (Table number 1)

Eight patients who underwent flap-in-flap head and neck reconstructions from January 2014 to January 2016 (four cases of primary PBFIF with nasolabial flaps and four cases of secondary PBFIF with pectoralis major myocutaneous flaps) were retrospectively studied. Our study involved six male

and two female patients with an average age of 45 years. Institutional ethical committee approval was obtained. Informed consents were obtained from all patients (for the display of photographs and the use of clinical material in research).

Inclusion criteria

Only those who had a head and neck regional flap-in-flap reconstruction were included.

Exclusion criteria

Those with comorbid illnesses and a smoking habit were excluded.

Preoperative Doppler Screening

A hand-held 10 MHZ Doppler was used to mark perforators within the skin paddle of the well-settled myocutaneous flaps (all cases were done 8 - 10 weeks following the primary reconstruction). All available perforators were marked for the secondary PBFIFs. Doppler-assisted localization of perforators was not done in the primary PBFIFs (nasolabial flap) as perforators overlaid the facial artery[20].

Surgical techniques

CASE 1. PRIMARY PBFIF (Figures 1-4)

A fifty-year-old male patient, who presented with a basal cell carcinoma of the right anterior cheek underwent excision. Intraoperative pathology demonstrated negative margins. The resultant defect was 5 X 4 cm (Figure 2). A nasolabial V-Y advancement flap was planned (Figure 2). The biogeometry of the flap was designed as shown in Figure 1. A single-Y flap would have been inadequate as the amount of advancement would have been less than that required, and the concavity of the advancing flap would have been a misfit for the medial canthal defect. Hence, a primary perforator-based flap-in-flap was planned at the advancing edge of the nasolabial flap. Perforators were located by a lateral exploratory incision. A separate single perforator for the skin island of the primary PBFIF at the advancing edge was located. With primary thinning a viable and mobile flap-in-flap was constructed. The medial incision was then completed and the flap-in-flap was advanced. (Figure 3 right). The remaining large flap was then advanced in a V-Y fashion and inset. Distinct venae commitantes are not found with the facial artery perforators in the subcutaneous plane. The venae commitantes break up into miniscule veins in the subcutaneous plane, and are therefore protected during dissection by leaving a cuff of subcutaneous fat down to the sub-SMAS plane around perforators.[20] The deeper plane of dissection was up to the sub-SMAS plane. This patient was followed up for a period of 18 months (Figure 4).

CASE 2. (SECONDARY PBFIF) (Figures 5-8)

A forty-two-year-old female patient presented with a left retro auricular squamous cell carcinoma invading the mastoid and underwent wide local excision and a radical neck dissection with removal of the external ear, the facial nerve trunk, the mastoid, and the squamous part of temporal bone. A cranioplasty with cover from the ipsilateral pectoralis major myocutaneous flap was performed (Figure 5). The patient developed partial distal necrosis of the flap with exposed bone. The resulting defect was reconstructed with a scalp rotation flap and two z plasties, but the dehiscence recurred (Figure 5). After locating the perforator with a doppler within the pectoralis major flap, a flap-in-flap was done based on a single perforator and advanced into the defect in a V-Y fashion (Figures 6 & 7). This secondary flap-in-flap could be designed on either side or in the middle of the well-settled cutaneous island of the pectoralis major flap. In this case, it was designed on the posterior part of the cutaneous paddle of the flap. The secondary flap sustained mild venous congestion at the edges that was relieved by removing alternate sutures on the first postoperative day. Stable cover was obtained and healing proceeded uneventfully. All secondary flap-in-flap cases received postoperative radiotherapy. This had no undue effect on flaps. No loco regional recurrence was noted at 14 months of follow up (Figure 8).

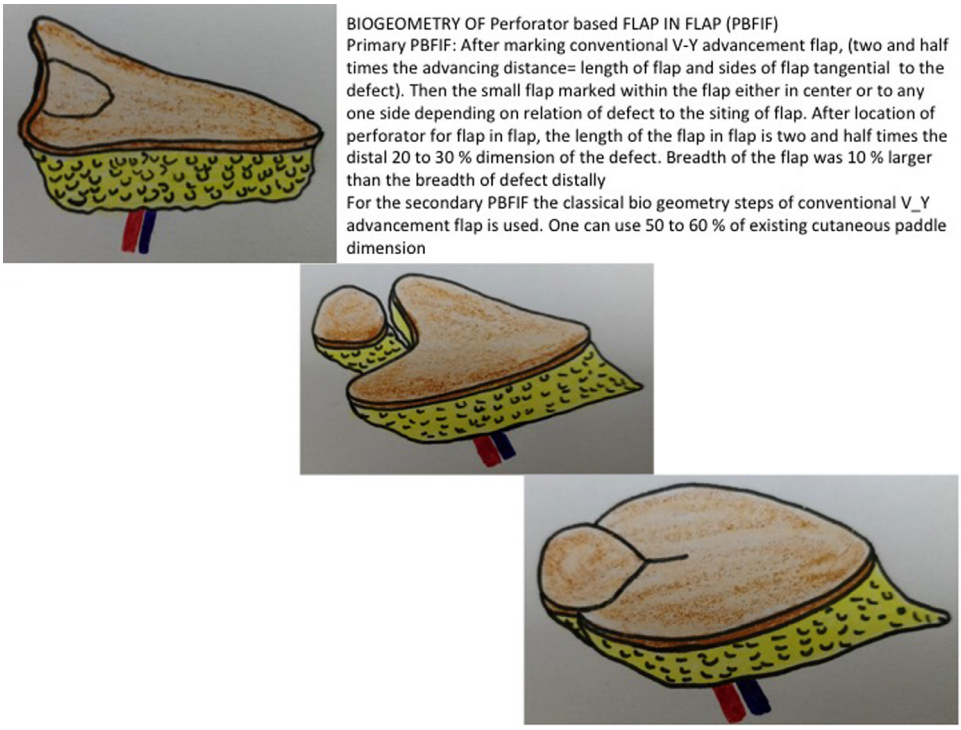

Figure 1. Biogeometry of flap-in-flaps.

Figure 2. CASE 1. With basal cell carcinoma in the right nasolabial region (left). After wide local excision planned for primary perforator-based flap–in-flap (right).

Postoperative Assessment

Patients were assessed at 3, 6, 12, and 18 months with a mean follow up of 16.75 months. At the end of follow-up period, two independent observers and patients assessed the outcome based on the IRAS.

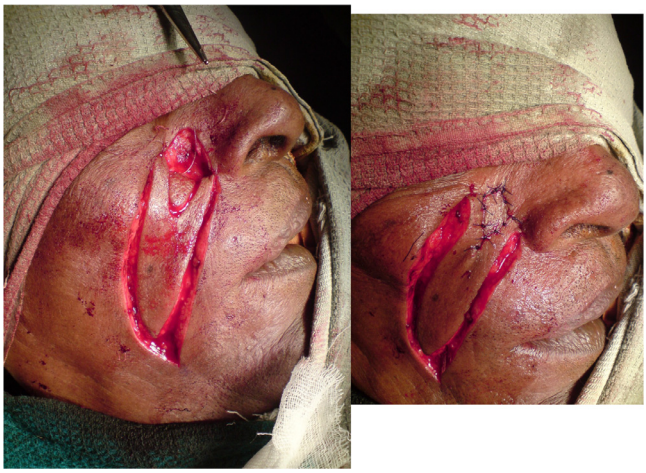

Figure 3. CASE 1. Primary perforator-based flap-in-flap in progress.

Figure 4. CASE1. Immediate and Late postop picture.

Results (Table 1)

The average size of the primary PBFIF (used in conjunction with a nasolabial advancement flap) was 2.1 square centimeters. The average size of the secondary (used in conjunction with pectoralis major myocutaneous flaps) PBFIF was 23.625 square centimeters. There was no partial or complete loss of any flaps in the primary or secondary cases. All PBFIFs involved V-Y advancement. All flap-in-flaps were raised on the single best perforator available. The average size of the perforator measured at the fascial and the subfascial level was 1.2 mm. Except for two minor complications (Table 1), no other complications were encountered. All flaps settled well. All these flaps were used for the reconstruction of postexcisional defects only. None of the patients had any loco regional recurrences. All 4 patients in the squamous cell carcinoma group involving the temporo-tympano-mastoid region had uneventful postoperative adjuvant RT. The mean IRAS score obtained in 8 patients was 3.5 (primary PBFIF=3.87 and secondary PBFIF= 3.12). None of the flaps resulted in the late distortion of adjacent

Table 1
Demographic data of the clinical cases

Case no	Age (in years)/Sex	Pathology	Procedures done and size of the flap (cms)	Complications	Follow-up period (months)	Average IRAS from two independent observers and patient at the end of follow up
1	50/M	BCC in NL region	Primary PBFIF in the adhoc nasolabial flap/1X 1.5	Nil	18	4
2	45/M	BCC in NL region	Primary PBFIF in the adhoc nasolabial flap/1.5X 1.75	Nil	14	3.5
3	40/M	BCC in NL region	Primary PBFIF in the adhoc nasolabial flap/1X 1.5	Nil	12	4
4	55/M	BCC in NL region	Primary PBFIF in the adhoc nasolabial flap/1.5X 2	Nil	18	4
5	40/F	SCC in the retro auricular region (stage 4) Dehiscence of the wound with infection at the distal site. After two procedures, dehiscence recurred.	Secondary PBFIF in the PMMC flap/5X4	Mild venous congestion at the suture line settled uneventfully	14	3.5
6	35/F	SCC in the external auditory meatus (stage 4). Partial distal necrosis of PMMC flap	Secondary PBFIF in PMMC flap/5X5	Nil	16	3
7	42/M	SCC in the external pinna (stage 4) Partial distal necrosis of PMMC flap	Secondary PBFIF in PMMC flap/6X4	Mild collection drained, healed well	22	3
8	46/M	SCC retro auricular (stage 4) sulcus. Dehiscence of the wound, mild infection at the distal site	Secondary PBFIF in PMMC flap/ 5X5	Nil	20	3

M- male; F- female
BCC- Basal Cell Carcinoma
SCC- Squamous Cell Carcinoma
NL-NasoLabial
PBFIF- Perforator-Based Flap-In-Flap
PMMC- Pectoralis Major Myocutaneous Flap
IRAS- Institutional Reconstruction Assessment Score:
1 Tender scar, hypertrophic bridle scar, and severe distortion of anatomical structures envisaging multiple secondary procedures.
2 Unsatisfied with the position and amount of scar, moderate distortion of anatomical structures requiring at least one revision procedure.
3 Satisfactory scar, minimal distortion of adjacent anatomical features.
4 Imperceptible scar at conversational distance, no distortion of adjacent anatomical structures.

Figure 5. CASE 2. With Squamous Cell Carcinoma involving the retro auricular sulcus invading middle, and external ear (Left) reconstructed with pectoralis major myocutaneous flap. Twelve weeks later, the recurrence of dehiscence after failed rotation and Z-plasty (right).

Figure 6. CASE 2. Desired thickness secondary perforator-based flap-in-flap marked and flap was raised on the single best perforator (Black Arrow).

anatomical landmarks by hypertrophy or scar contracture. Clinical details of all patients are shown in Table 1.

Discussion

"Flap-in-flap" was first described by Hyakusoka et al[17] in 2006, as a method of enhancing the advancement of VY flaps by borrowing the excess tissue along apices of the advancing edge as a primary procedure. Hyakusoka et al described in their article, how the concave-advancing edge of the VY advancement flap would be a misfit for the concave distal edge of the round defect. Hyakusoka et al described this for alar base reconstruction, but all were raised on the gross separate random subcutaneous pedicle. Turgut et al[18] described the flap-in-flap reconstruction method in the medial canthal region utilizing two adjacent pedicled glabellar flaps. By definition, these were not flap-in-flaps. A prelude to the Hyakusoka study was Nakajima[19] et al study. None of these reports[17-19] appeared to

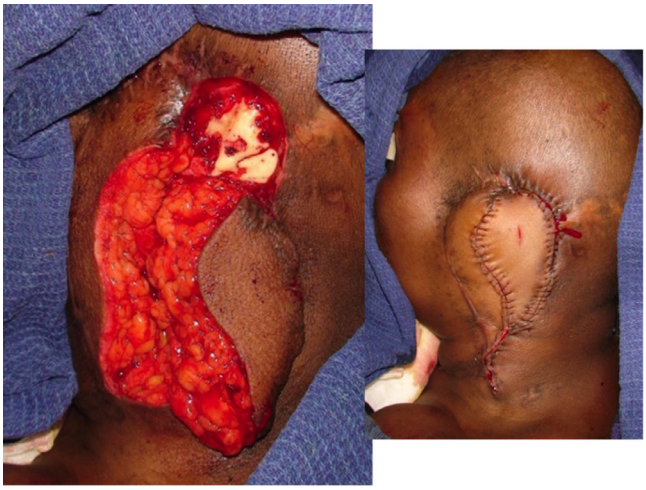

Figure 7. CASE 2. Secondary perforator-based flap-in-flap in progress.

use perforator-based dissection for flap-in-flap reconstruction. The variation described in this paper provides the following benefits:

1. Curved advancing edges of the flap-in-flap fits into defects congruently without any secondary movements from adjacent areas that can produce the distortion of anatomical landmarks.
2. PBFIFs provide independent and additional mobility.
3. PBFIFs enhance the advancing distance of classical V-Y advancement flaps.
4. Creating perforator-based flap-in-flaps increases the robustness of blood supply by decreasing the steal phenomena.[20]
5. Secondary PBFIFs possess angular vector mobility particularly when peri-perforator dissection is done through the atrophied pectoralis major musculature.
6. PBFIFs are technically less demanding to execute than free flaps.
7. Thin pliable PBFIFs (with good color and texture match) breaks up the tendency of pincushioning to form in concave areas like the medial canthal region.
8. PBFIFs promote a tension-free inset, thereby improving final esthetic results. This is also reflected in the IRAS results.

Various techniques to increase the advancing distance of flaps have been described. Pribaz et al[21] incorporated a hinged transposition flap at the advancing edge of V-Y advancement flaps. But these were random pattern flaps and the mobility of the secondary flap at the edge was largely restricted. In 1988, Chan et al[22] described the technique of undermining the triangular flap at its apex, to increase the length and unfold the flap. But these were again random patterns and the blood supply at the advancing edge was maintained by cumbersome oblique dissection. In 2003, Behan F.C [23] designed the keystone perforator island flap to close elliptical defects. But these trapezoidal flaps were closed at maximum tension at the middle of the defect with the risk of breakdown. For circular defects at the dorsum and tip of nose, Cronin et al[24] used V-Y rotational flaps. There was V-Y advancement at the glabella region. Here, there was bridle scar at the radix with restricted advancement of the flap despite the combination of rotation and V-Y advancements.

Although much has been written on the thoracoacromial artery perforasomes[25, 26,27,28], to date there is no data on the secondary reconstruction of postexcisional defects using the terminal pectoral branch perforator from the thoracoacromial vascular axis. This technique of secondary PBFIF is an extension of the perforasome concept[29].

Limitations of this study are small sample size, usage of the PBFIFs only for postexcisional head and neck soft tissue defects and all secondary PBFIFs were completed with the pectoralis major my-

Figure 8. CASE 2. Late postoperative picture.

ocutaneous flap, which is particularly suited to this technique. Others may have preferred to use free flaps to reconstruct these large defects. However, free flaps are also not without their problems and can also undergo partial necrosis. It is possible that in such scenarios PBFIF could also be used.

Conclusion

PBFIF is a viable technique to cover defects when there is a paucity of tissue and where anatomical distortion is to be avoided. It is a useful option for a tension-free flap inset with a robust blood supply unlike the random pattern subcutaneous pedicled flap-in-flap. PBFIF is an adjunctive procedure in the salvage reconstructive armamentarium of plastic surgeons. These results are preliminary and long-term verification of the validity by others will be needed to further popularize this technique.

Declaration of Competing interests

None.

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