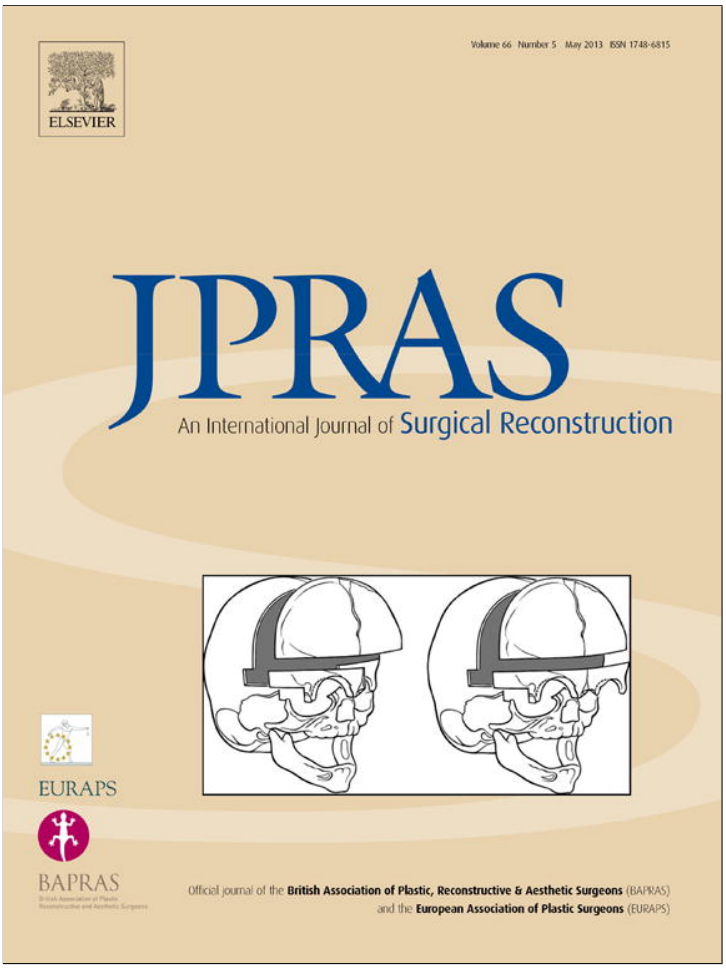

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Scalp reconstruction with superficial temporal artery island flap: Clinical experience on 30 consecutive cases

Stefania Tenna, Beniamino Brunetti*, Achille Aveta, Igor Poccia, Paolo Persichetti

Plastic and Reconstructive Surgery Unit, Campus Bio-Medico University of Rome, Rome, Italy

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Summary *Background:* Different techniques are available to reconstruct scalp defects; however, when the cranium is exposed or the hairline compromised, the procedure may become quite challenging. The use of superficial temporal artery fascio-cutaneous flaps has been described mainly to restore the hair-bearing surface of the upper lip or the eyebrow but only few applications in the scalp have been reported. The authors present their experience with the use of superficial temporal artery island flaps to obtain durable coverage and excellent contour in anterior scalp reconstruction.
Methods: Thirty consecutive defects in the anterior scalp subunits (temporal = 14; parietal = 12; forehead = 4) were reconstructed with ipsilateral V-Y island flaps nourished by frontal and parietal branches of the superficial temporal artery. All defects resulted from skin cancer excision. Twenty-six flaps were based on the parietal branch. The frontal branch pedicle was used in only four cases to resurface defects in the forehead subunit. Glabrous skin flaps were harvested in six patients. Including a venous branch in the pedicle was not mandatory because the venous drainage of the flaps was provided by the perivascular fascial network. For this reason, a fascial pedicle around the artery, 2—3 cm in width, was maintained to minimise flap venous insufficiency.
Results: Twenty-nine flaps healed uneventfully (96.7% flap survival rate), providing stable coverage with a mean follow-up of 12 months. In the early postoperative time (up to 48 h), slight venous stasis was observed in 14 flaps (46.6%), but it resolved spontaneously within 1 week. Two flaps showed severe venous stasis, but in only one case (3.3%) it progressed to distal necrosis requiring surgical revision. No cases of alopecia or hairline distortion were postoperatively registered.

* Corresponding author. Tel.: +39 3386878711; fax: +39 06225411933.
E-mail address: b.brunetti@unicampus.it (B. Brunetti).

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Conclusions: The use of superficial temporal artery island flaps, mobilised in a V-Y fashion, proved to be an elegant and reliable solution to resurface defects in the anterior scalp subunits in both hairy and bald patients.

Scalp defects, commonly secondary to trauma, burns or cancer excision, need to be repaired in a manner that takes into account the peculiar features of skin and subcutaneous tissue of this area as well as its anatomic and aesthetic subunits. The galeal aponeurosis is responsible for the majority of resistance to scalp flap advancement, but excessive tension at wound closure can cause alopecia and should always be avoided.

According to the complexity of the defect, a reconstructive ladder is usually followed. Primary closure can be chosen in cases of small superficial defects (<2 cm^2), while for larger and full-thickness defects (2—25 cm^2) local flaps are often necessary.[1] Healing by secondary intention or skin grafts is reserved to patients who are poor candidates for major reconstructive procedures[2]; however, just as in extensive reconstructions with free tissue transfer, all these techniques are challenged by unsatisfactory aesthetic and functional results, because of the poor match with recipient site, ulceration and alopecia.

On the other hand, even for small to medium-size defects in the anterior scalp subunits, large flaps mobilised in a rotation, transposition, advancement or an island fashion may be required, thus having all the disadvantages related to classic random flap design in terms of distal vascularisation and distortion of hairline and contour.

Temporoparietal fascia flap (TPFF) represents one of the most useful tools in head and neck reconstructive surgery for its versatility, pliability and wide pedicle rotational arc.[3] The use of antegrade flow superficial temporal artery (STA)-based island flaps has been described by many authors, in particular to resurface hair-bearing defects of the upper lip[4] and the eyebrow.[5] Nevertheless, few case reports or short case series in the literature have investigated its role in the reconstruction of scalp defects.

The authors present their experience with the use of antegrade flow STA-based island flaps in 30 consecutive anterior scalp reconstructions, showing their long-lasting results with full restoration of contour and hairline.

Methods

Relevant surgical anatomy

The TPF is the cranial extension of the superficial musculoaponeurotic system (SMAS) of the face, continuing superiorly with the galea aponeurotica, anteriorly with the frontalis muscle and posteriorly with the occipitalis muscle. Below the TPF lies a loose areolar plane (innominate fascia), which separates the TPF from the deep temporal fascia. The nutrient vessels to the TPFF are the STA and the superficial temporal vein (STV), supplying all the layers of this area (from the skin to the muscle). The STA, after its origin from the external carotid, passes into the parotid gland, deep to the facial nerve, and courses superiorly at the upper preauricular level, lateral to the temporal mandibular joint. Above the zygomatic arch, 1—1.5 cm anterior to the tragus, the STA enters the two layers of the TPF. At that level, from 0.5 to 2 cm above the tragus, it divides into the frontal and parietal branches in 90.9% of cases.[6] The frontal branch runs parallel and superior to the temporal branch of the facial nerve towards the frontalis muscle, forehead skin and frontal scalp and forms an anastomotic network with the supratrochlear and supraorbital arteries, allowing for flap elevation in a reverse-flow fashion.[7—10] The parietal branch continues directly to the midline of the parietal scalp towards the vertex. The posterior branch has connections with the posterior auricular artery and occipital artery. The STV usually runs apart from the STA, except for its proximal portion. STV usually courses posterior to the artery but in 9.1% of cases has been found as a single vein just anterior to the parietal branch of the STA.[6]

Preoperative planning

The scalp of the patient is shaved along the presumed course of the STA and its distal branches to achieve a meticulous Doppler mapping of the pedicle. The hairline is marked and the frontal branch course is depicted to avoid surgical damage to the temporal branch of the facial nerve.[11] Depending on the course of the pedicle and the defect location, the flap is planned as centred on or intersected by the parietal or the frontal branches.

The parietal branch is always preferred and its course is followed from its origin by the main trunk to the near proximity of the defect. The frontal branch pedicle is chosen only in rare cases of glabrous forehead reconstruction and the patient is warned about possible postoperative transient or definitive brow ptosis. If the defect is located in the temporal region, the flap is intended as a true fasciocutaneous flap, with the fascial component represented by the TPF. For all the non-temporal defects, galeo-cutaneous flaps are harvested, with the TPF in continuity with the galeal layer of the flap acting as the vascular carrier of the pedicle. The flap is always drawn in a triangular fashion in order to primarily close the donor site by V-Y flap advancement. A 4-cm exploratory incision is depicted 1—2 cm behind the audible pedicle to minimise the risk of damaging the vessels during their exposure.

Surgical technique

The surgery is performed under local anaesthesia with the aid of 2.5$\times$ loupe magnification. The exploratory incision is infiltrated with 2% carbocaine, and the two cutaneous flaps are dissected just below the hair follicles and reflected to expose the pedicle. In this part of the dissection, meticulous care is paid to avoid damage to STV branches, which usually course posterior to the artery and in a more superficial plane above the TPF. Once the pedicle is

visualised, the flap, including the skin, TPF, galea and innominate fascia, is easily harvested in a pre-periosteal plane from a cranial to a caudal direction.

Including a venous branch in the pedicle is advisable but not mandatory because the venous drainage of the flap can be sustained by the perivascular fascial network. For this reason, when a branch from STV cannot be included in the pedicle, a fascial extension around the artery, 2–3 cm in width, is maintained to minimise flap venous insufficiency.

The flap pedicle is freed until the flap can be transferred to the recipient site without tension. Direct closure of the donor area is accomplished by V-Y flap advancement. Multiple Penrose drains are placed to avoid pedicle compression by eventual haematoma. Patients are discharged on postoperative day 2.

Patient population

Between March 2010 and January 2012, 30 consecutive defects in the temporal (14), parietal (12), and forehead (4) regions were reconstructed with ipsilateral STA-based island flaps. The sexual distribution was as follows: 17 male patients and 13 female patients. Mean age at the time of surgery was 70 years. All defects were results of skin cancer ablation (basal cell carcinoma = 16; squamous cell carcinoma = 10; melanoma = 4). The mean defect size was 4.5 × 3.6 cm. Mean flap dimensions were 7.5 × 4 cm. All patients underwent a two-stage procedure, waiting for clear margins on pathology after cancer excision.

Twenty-six flaps were based on the parietal branch of the STA. The frontal branch pedicle was used in only four cases to resurface defects in the forehead subunit. Venous drainage was provided by STV branches in 12 cases and by perivascular fascial network in 18 cases (Table 1).

In one case, a section of the temporal branch of the facial nerve had already occurred for oncologic purposes; in the other cases, the nerve was preserved.

In 24 cases, hair-bearing flaps were transferred, while in six patients glabrous skin flaps were mobilised to obtain a 'like with like' reconstruction in two parietal scalp reconstructions in bald patients and four forehead reconstructions (Figures 1–3).

Results

All flaps achieved an adequate and durable reconstruction with excellent contour. The mean operative time was

Table 1 Patients population.

ID	Scalp subunit	Flap dimensions	Venous pedicle (Fascial, STV branches)	Complications
1	Parietal	8 × 4 cm	Fascial	Severe venous stasis; distal flap necrosis
2	Temporal	7 × 4 cm	Fascial	None
3	Temporal	11 × 6 cm	Fascial	Slight venous stasis
4	Temporal	6 × 3 cm	STV	None
5	Forehead	6 × 3.5 cm	Fascial	None
6	Parietal	8 × 4.5 cm	Fascial	Slight venous stasis
7	Temporal	10 × 5.5 cm	Fascial	Slight venous stasis
8	Temporal	10 × 5 cm	STV	None
9	Temporal	6 × 3 cm	STV	None
10	Parietal	12 × 7 cm	STV	None
11	Parietal	6 × 3 cm	STV	None
12	Temporal	8 × 4.5 cm	Fascial	None
13	Parietal	7 × 4 cm	Fascial	Slight venous stasis
14	Parietal	6 × 3.5 cm	Fascial	Slight venous stasis
15	Forehead	12 × 4.5 cm	STV	Severe venous stasis; brow ptosis and asymmetry
16	Temporal	7 × 4 cm	Fascial	Slight venous stasis
17	Temporal	6 × 3 cm	STV	None
18	Parietal	6 × 3 cm	STV	None
19	Forehead	7 × 3.5 cm	Fascial	Slight venous stasis
20	Temporal	10 × 5 cm	Fascial	Slight venous stasis
21	Parietal	7 × 4.5 cm	STV	None
22	Temporal	8 × 4 cm	Fascial	Slight venous stasis
23	Parietal	6 × 4 cm	STV	None
24	Temporal	8 × 4.5 cm	Fascial	Slight venous stasis
25	Temporal	6 × 3 cm	Fascial	Slight venous stasis
26	Temporal	6 × 4 cm	Fascial	Slight venous stasis
27	Forehead	7 × 3 cm	STV	None
28	Parietal	6 × 3 cm	STV	None
29	Parietal	7 × 4 cm	Fascial	Slight venous stasis
30	Parietal	6 × 3 cm	Fascial	Slight venous stasis

Figure 1 Defect in the right parietal subunit at the hairline junction with the forehead (above left); the flap harvested and advanced towards the defect (above right); two weeks post-operatively, notice hair growing on flap surface (below left); six months postoperatively, no distortion of the hairline and hair direction is registered (below right).

Figure 2 Defect in the left temporal subunit at the hairline junction, involving the sideburn: the parietal branch of the superficial temporal artery has been preserved during surgical resection and its viability has been confirmed by means of pre-operative Doppler examination (above left); the flap, harvested without the need for any explorative incision, is islanded on the parietal branch, that was found to course through the granulation tissue (above right); two weeks post-operatively, notice hair growing on flap surface (below left); six months postoperatively, temporal and sideburn hairline has been successfully reconstructed (below right).

Figure 3 Wide defect with partial bone exposure in the left glabrous forehead subunit after squamous cell carcinoma excision (above left); the flap islanded on the frontal branch of the superficial temporal artery, the supraorbital nerve has been preserved (above right); severe venous stasis observed in the early post-operative follow-up, relieved with conservative treatment, consisting in partial flap de-suturing (below left); six months postoperatively, notice the perfect match with the surrounding tissues provided by a "like with like" reconstruction (below right).

75 min. Twenty-nine flaps healed uneventfully (96.7% flap survival rate). In the early postoperative time (up to 48 h), slight venous stasis was observed in 14 flaps (46.6%), but it resolved spontaneously or with partial flap de-suturing within 1 week. Two flaps showed severe venous stasis (Figure 3), but in only one case (3.3%) it progressed to distal necrosis requiring surgical revision. No cases of hairline distortion or alopecia involving flap margins and flap surface were postoperatively registered. All the patients were discharged on postoperative day two. Drains were removed before discharge. The first 24—48 h were crucial to assess the vascular modifications of the flaps. Hair growing on flaps surface was postoperatively documented. Mean follow-up was 12 months (range 3—24 months).

Discussion

The use of vascularised pedicled temporoparietal fascia is indicated in a wide range of clinical situations, extending from auricular reconstruction and facial soft tissue augmentation to skull base, orbital and intra-oral reconstruction.[3] More recently, the pre-auricular region has been advocated as an ideal donor site for harvest of retrograde flow STA-based island flaps to achieve an elegant resurfacing of non-hair-bearing defects in mid-facial subunits, eyelid and nasal ala.[12]

Nevertheless, the antegrade flow hair-bearing soft-tissue transfer has restricted clinical indications and is limited to upper lip defects in male patients by means of interpolated unilateral or bilateral fascio-cutaneous flaps[4] or to total/subtotal brow reconstruction[13] with the tunnelled fascio-cutaneous hair-bearing flap.

Up until now, STA-based V-Y advancement island flaps have rarely been reported in the scalp,[14] and used only for reconstruction of damaged forehead[15] or sideburn.[16]

Kwon[17] and Sharma[18] have already published cases of posterior scalp reconstructions with occipital artery-based flaps, but our clinical series represents the largest report on antegrade flow STA-based island flaps in scalp reconstruction.

In our experience, this flap offers clear advantages to resurface defects in the temporal, parietal and frontal scalp subunits in both hairy and bald patients, especially

when the use of traditional techniques (skin grafts and random pattern flaps) may produce distortion of important anatomical structures such as anterior or temporal hairline, eyebrow or sideburn.

The technique presented allows to design scalp and forehead flaps on the distal branches of the STA and to obtain a 'like with like' reconstruction for defects located in the anterior scalp and forehead regions, with minimal violation of the above-mentioned structures.

In the first cases performed we relied on the clinical experience reported by other authors[19,20] maintaining a 2—3-cm-wide fascial extension around the artery to provide the anatomical substrate for venous drainage. In these cases, less attention was paid to spare STV branches during pedicle dissection and a higher rate of venous stasis was registered, especially in those flaps designed more cranially on the parietal scalp to obtain a longer pedicle able to reach the defect without tension. However, clinical observation revealed slight venous insufficiency to be a self-limiting phenomenon, to be considered as a consequence of the peculiar vascular anatomy of the flap rather than a complication of the surgical dissection.

As a matter of fact, in the subsequent cases we started performing a more meticulous sub-follicular dissection to identify and include visible venous branches in the pedicle, experiencing a significant reduction in the venous insufficiency rate. For this reason, even if the technique proved to be quick and reliable, with a very high flap survival rate (96.7%), we strongly recommend to adopt this surgical expedient to improve flap vascularisation and postoperative recovery.

The frontal branch of the STA was used in four cases for reconstruction of the forehead subunit. In those cases, special care should be taken to avoid damage to the temporal branch of the facial nerve during flap elevation. The surgeon must remember that the nerve ascends between the split layers of the superficial lamina of the STA and then courses between its deep and superficial laminae to reach the frontalis muscle, corrugators, procerus and portions of the orbicularis oculi muscle. Therefore, patients need to be warned about the possibility of postoperative transient or definitive brow ptosis and/or asymmetry. Nevertheless, in our series the use of 2.5× loupe magnification allowed us to avoid this complication, limiting it to only one patient who developed brow ptosis after oncologic tumour resection.

Moreover, our experience integrated the reports by Rocha[21] and Sharma,[22] who described V-Y myo-cutaneous forehead flaps based on supratrochlear or supraorbital pedicles, showing that the same flaps can be safely harvested on the STA pedicle.

Finally, careful flap planning and meticulous pedicle dissection proved to be crucial to gain excellent results; in very selected cases, a closed approach[23] for the dissection of the fascial pedicle, without the need for any explorative incision, can be adopted.

Conclusions

Scalp reconstruction represents a challenge, as the reconstructive surgeon should strive for a cosmetically appealing result as well as for durable coverage to the exposed cranium. Restoring the hair-bearing surface without distortion of the hairline and hair direction and avoiding alopecia is an important goal. In our experience, V-Y STA-based island flaps proved to be an elegant and valid solution. Due to the ease of dissection, clinical reliability (96.7% flap survival rate), primary closure of the donor site and optimal match with the recipient site, we recommend their use in case of small to medium-size defects in the temporal, parietal and frontal scalp subunits, especially when the use of traditional techniques may produce distortion of anterior or temporal hairline, eyebrow or sideburn.

Conflict of interest/funding

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