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A new gold (old) standard for nose reconstruction: The one-stage midline forehead flap – a 13-year retrospective review of results using the central vein and inverted-kite pedicle base modification

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Background. A detailed study of the blood supply of the forehead has led to precise landmarks for midline forehead flap planning, similar to the old Indian rhinoplasty landmarks described by Daver and Antia. Further investigation into pedicle rotations has shown that the best technique for one-stage pedicle inset was to use an inverted-kite pedicle base modification of the midline forehead flap.
Objective. To carry out a retrospective review of all the cases using the one-stage inverted-kite midline forehead flap (OSIKMFF) operated on by the author between January 2006 and September 2018.
Methods. The retrospective review gathered information on patients' age, pathology, flap design and complications.
Results. Twenty patients were included in the study. Most data for 2008 were, unfortunately, lost, but patients whose data were retrievable were included. The average age of the patients was 57 years (range 21 - 84). The male-to-female ratio was 1:1 (10 v. 10). The most common pathology was basal cell carcinoma, which was present in 18/20 (90%) cases, and the remaining 2 (10%) patients had melanoma. Only in two (10%) cases was tissue expansion used before the OSIKMFF. All the flaps survived, and the blood supply was very robust. Complications were minor.
Conclusion. The one-stage forehead flap using the inverted-kite pedicle base modification is a useful technique, based on meticulously identified safe landmarks, the robust blood supply, meticulous cadaver dissections and clinical experience over many years.

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Forehead flaps are well known for their reliable blood supply, hence the successful use of this flap over thousands of years.[1,2] A detailed study of the blood supply of the forehead has led to the identification of precise landmarks for midline forehead flap planning, similar to the old Indian rhinoplasty landmarks described by Daver and Antia.[3] Further investigation into pedicle rotations has shown that the best technique for one-stage pedicle inset was to use an inverted-kite pedicle base modification of the midline forehead flap.[4] Other authors have described their positive experiences with the one-stage forehead flap, but despite this, the paramedian forehead flap became the gold standard flap in the West.[5-10]

The correct application of the landmarks and pedicle base modification allows for one-stage pedicle inset of a reliable robust flap, and almost no need for pedicle separation at a second stage.[4] This depends on the reconstructive demands of the defect. In some cases, only pedicle base refinements or minor debulking may be necessary. Some cases may require complete flap elevation, in which case the blood supply and sensation can be safely maintained, which is not practical with a paramedian forehead flap once the pedicle has been separated. The one-stage forehead flap may be highly advantageous for surgeons doing missionary surgery where surgeon follow-up is suboptimal, and one-stage primary surgery with minimal secondary operations is ideal. It is also a useful procedure in elderly patients, for whom ultimate aesthetic outcomes may be less important. Using fewer stages means that there is less cosmetic refinement, but using the one-stage inset technique does not mean that further stages for refinement cannot be done. In the author's experience, the paramedian forehead flap has become as obsolete as a cross-leg flap.

Methods

A retrospective review was carried out of all the cases operated on from January 2006 until September 2018 by the author. The technique used for midline forehead flap planning is as follows: any scars or injuries to the arterial pedicles must be excluded by clinical examination of the facial skin overlying the source arteries, from the facial artery to the angular artery, the dorsal nasal artery, the central artery, the paramedian and the supratrochlear artery communicating branch area in the medial canthal region.[2] Next, a central vein of the forehead should be found. This vein is more prominent when patients frown, become emotional, or valsalva, or when they are in a prone position. The vein is a cutaneous landmark of the subcutaneous arterial patterns.[3] When present, the central vein is then used as the central axis for the flap. Since the central arteries are tightly woven around the central vein and have interarterial communications, it is possible to design a narrow pedicle of about 5 - 10 mm in width.[4] As the central vein drains into either left or right orbits in the supramedial canthal region (the frontonasal angle), the pedicle base will turn in that direction. A rare central arterial and venous variation is that the vein may be exactly in the midline, and fork at the glabella to drain into the medial canthal areas.[4] This vein has been named a median vein, and has a corresponding

median artery.[3] The limits of the medial pedicle margin are the midline, the medial canthal horizontal line inferiorly to a point 5 mm medial to the medial canthal vertical line. The lateral pedicle margin should also not be closer than 5 mm to the medial canthal vertical line at the pedicle base over the medial orbital rim (Fig. 1). In cases where a central vein cannot be seen or found, the pedicle is designed according to the landmarks given (Fig. 1).

Fig. 1. Safe landmarks for midline forehead flap design are shown, with or without a central vein as the flap axis.

Fig. 2. Profile after flap inset has no humps, and patient can safely wear glasses.

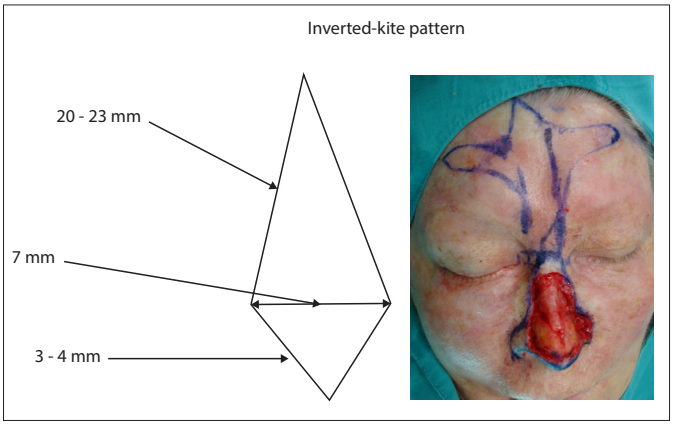

Fig. 3. Inverted-kite pedicle design for one-stage flap inset.

The best design of the pedicle to achieve a one-stage inset was studied in five cadavers.[4] The inverted-kite design gave the best profile result for pedicle inset for a one-stage midline forehead flap (Fig. 2). The dimensions of the inverted-kite skin excision at the pedicle base are approximately 20 mm superiorly × 7 mm wide × 3 mm inferiorly (Fig. 3). Only epidermis and dermis with minimal subdermal fat is excised when cutting and removing the inverted-kite pattern at the pedicle base. Adjacent lateral nasal wall skin is dissected loose with scissors. A further requirement for the one-stage inlay is that the dorsal nasal skin must be removed, to make place for the flap and pedicle.

Results

A total of 20 patients were included. The demographic data of the patients are shown in Table 1. Most data for 2008 were, unfortunately, lost. All patients whose data were retrievable were included.

The average age of the patients was 57 years (range 21 - 84 years). The male-to-female ratio was 1:1 (10 v. 10). The most common pathology was basal cell carcinoma, which was present in 18/20 (90%) cases, and the remaining two (10%) patients had melanoma. Only in two (10%) cases was tissue expansion used before the one-stage inverted-kite midline forehead flap (OSIKMFF).

All the flaps survived, and the blood supply was very robust (see Fig. 4). There were some relatively minor complications, such as minor dehiscence of an ala and postoperative swelling (2/20; 10%), and cosmetic revisions for slight bulging at the pedicle inset (2/20; 10%). Minor pedicle base modifications were made in four cases, 2 weeks postoperatively, for cosmetic purposes, to perfect the results (4/20; 20%). One patient had partial necrosis of the left ala after sleeping with the ala on his arm on day 2 postoperatively (1/20; 5%).

Discussion

The routine success of the OSIKMFF, despite not using a Doppler for pedicle identification, and even in cases without a visible central vein as pedicle axis landmark, can be ascribed to accurate landmarks for flap planning based on the underlying vascular anatomy (examples of results are shown in Fig. 5). The midline forehead flap was previously considered an axial flap, based on the supratrochlear artery, and some reports identified branches from the angular artery.[11-14] The more accurate identification of the axial arteries of the midline forehead flap was demonstrated to be the central

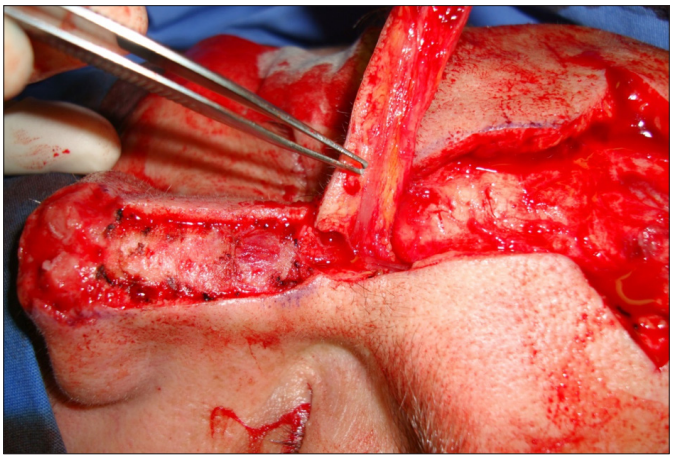

Fig. 4. Flap elevation with intact neurovascular bundle shown.

Table 1. Demographic data of patients who had reconstruction using forehead flap technique (2006 - 2015)

Patient	Year	Age	Sex	Pathology	Flap
1	2006	75	M	Melanoma lower lid	MFF, CV
2	2006	84	M	BCC nose and cheek	MFF, CV
3	2006	64	M	BCC nose	MFF, CV
4	2007	43	F	BCC nose dorsum	OSIKMFF
5	2007	21	F	Burned nose	TE and OSIKMFF
6	2007	84	M	BCC nose	OSIKMFF
7	2007	67	F	BCC nose	OSIKMFF
8	2008	83	F	BCC nose	OSIKMFF
9	2009	45	F	BCC lateral nose; cheek	OSIKMFF
10	2009	75	M	BCC nose	OSIKMFF
11	2010	75	F	BCC nose	OSIKMFF
12	2011	30	M	Dog bite nose	OSIKMFF
13	2011	26	F	BCC canthus and nose	OSIKMFF
14	2011	80	M	Recurrent BCC nose	OSIKMFF
15	2012	51	F	BCC nose	OSIKMFF
16	2012	67	M	Necrotising fasciitis	TE and OSIKMFF
17	2012	58	F	BCC nose	OSIKMFF
18	2015	82	F	Recurrent BCC	OSIKMFF
19	2015	53	M	BCC nose	OSIKMFF
20	2015	75	M	BCC nose	OSIKMFF

MFF = midline forehead flap; CV = central vein; BCC = basal cell carcinoma; OSIKMFF = one-stage inverted-kite midline forehead flap; TE = tissue expansion.

or paracentral arteries, originating from the dorsal nasal artery or from the angular artery.[4] The use of the forehead central vein as a landmark for flap planning was proposed based on the close association of the central vein to the central artery and paracentral artery, as found in multiple cadaver dissections.[4] It was shown that the central vein is not associated with the supratrochlear arteries. New terminology for the arteries associated with the vein was therefore introduced.[4]

There is no published randomised blinded prospective clinical study to compare the inclusion of the vein with a control where the vein is not included. Since the patterns and presence of the vein vary, the inclusion of the vein in the flap is not guaranteed by using the safe landmarks for flap design given, but the arteries are included.[4] There is more variation of the supratrochlear artery in relation to unilateral absence in the hemiforehead, in comparison with the central artery.[3] This therefore indicates that the central arterial supply to the forehead is more consistent than the paramedian supply from the supratrochlear artery. Variations of the central vein have been described, and it has been shown that they may be present bilaterally to the midline, and in rare cases, a singular absolute median vein (and corresponding median artery) may be present, dividing at the nasal glabella area to drain bilaterally into the medial canthal areas.[4] The vein is more commonly either to the left or right of the midline.[4] The benefit of using the central vein, then, is that it is a macroscopic cutaneous landmark of the underlying arterial pattern, and thus makes the selection of the site and drawing of the pedicle easier. Secondly, and theoretically, it is always safer to include a vein with an artery in a flap, since flaps are more sensitive to venous occlusion than arterial occlusion.[15] When the flap is planned according to the landmarks, and without a central vein identified, the inclusion of a vein is not guaranteed. A supratrochlear vein is not as common as a central vein, and therefore it cannot be used as a cutaneous landmark for the flap axis of a paramedian forehead flap as reliably as the midline forehead flap and central vein.[4]

We had a very low necrosis rate in our patients, which is in keeping with the literature. Historically, the midline forehead flap has been shown to be a robust flap, yet not without occasional partial flap necrosis. The application of the knowledge of the location and variation of the arterial pattern and central vein, theoretically and, as shown by this study, practically, can contribute to even safer and more robust pedicles. The low pedicle base position makes a long pedicle, as required with a paramedian forehead flap, unnecessary. The narrow pedicle allows for greater manoeuvring of the flap. The tortuous bend (or 'genu') of the supratrochlear artery as it passes through the frontalis muscle at, or superior to, the brow level may be compromised by rotation of a narrow pedicle in a paramedian forehead flap.[4] The midline forehead flap provides more pedicle length owing to a shorter distance from the rotation point to the defect. It is the best choice in a short forehead, where, if one had to use a paramedian forehead flap, adjusted techniques such as oblique flap designs or tissue expansion might be considered in certain cases.

Another advantage of the midline over the paramedian forehead flap is that there is no pedicle (although only temporary) over the medial eye, obstructing vision, and no raw wound (especially compared to one-stage flap inlay), with its associated discomfort to the patient. In addition, a skin graft is not used at the pedicle base with the one-stage flap inlay.

The secondary modifications were for excision of excess skin, to obtain a smooth dorsal nose transition between flap and adjacent skin, or for minor bulges at the pedicle base due to flap rotation. The vascular pedicle of the flap is kept intact during the secondary revision. It is possible to elevate the skin over the pedicle base without damaging the pedicle. Most patients presenting with nasal skin cancers are elderly, and wear glasses, and the design of the one-stage inset allows patients to wear their glasses almost immediately postoperatively, as this does not compromise flap blood supply. The pressure points of spectacles, when worn, are usually laterally medial and inferior to the pedicle blood supply. Therefore,

although there is a degree of compression at the base of the nose by the glasses, it has not led to any case of partial or total necrosis where the central vein planning was used. Some case results are shown in Figs 5A - 5D.

The paramedian forehead flap always requires a second stage, but the one-stage midline forehead flap does not.

The one-stage design allows minimal secondary pedicle modification, the maintenance of the blood supply during secondary flap elevation, and wearing of glasses postoperatively.

Unlike in the technique used by Park,[8] there is no need to resect any muscles, such as the procerus.

One sacrifice required in a one-stage inlay is the fact that the dorsal nose skin has to be removed. Although sacrificing normal tissue may seem a disadvantage, it is cosmetically beneficial, allowing blending of the cosmetic subunits of the nose. The dorsal nasal skin in most such patients has multiple areas of solar keratosis or solar damage, and therefore this might in general be good for the patient in the long run.

The benefits of the one-stage midline forehead flap using the central vein in comparison to the paramedian forehead flap are summarised in Table 2.

The only disadvantage of a one-stage forehead flap is that if further improvement of the cosmetic result is needed, then more stages will be required. The main benefit that makes the method stand out above the paramedian forehead flap, in this instance, is that the pedicle can be kept intact with any future stage refinements.

In the comparison of the advantages and disadvantages of the paramedian forehead flap v. the OSIKMFF, it is the latter that clearly results in less patient morbidity, and has greater advantages. With the superior advantages of

Figs 5A and B. Patient 1, before and after OSIKMFF surgery.

Figs 5C and D. Patient 2, before and after OSIKMFF surgery.

Table 2. Feature comparison of OSIKMFF v. PMFF use

Factor	OSIKMFF	PMFF
Axial flap	Central; paracentral arteries	Supratrochlear artery
Cutaneous venous landmark	Often visible central vein	Seldom visible supratrochlear vein
Safe anatomic pedicle landmarks	Yes; minimal arterial variation (3%)	Arterial variations and absence common (>60%)
Inclusion of visible vein	Often	May require wider base to include vein
Narrow pedicle	Safe	May compromise flap
Pedicle length	Long possible; short forehead less problematic	Restricted; requires longer pedicle
Visual obstruction by pedicle	None	Common
Raw pedicle wound	None	Common
Second stage required	Seldom	Always
Pedicle flow cut at second stage	No; arterial and venous flow can be maintained	Yes
Secondary revision	Minor	Major compared with OIKMFF
Postoperative wearing of spectacles	No problem (beneficial to older patients)	Normal wear not possible
Sacrifice normal nose skin	The rule	Not the rule
Aesthetic subunits	Total resurfacing common	Not common
One stage	Always possible	Not recommended
Sensation in flap maintained	Yes	Seldom
Skin graft of pedicle	Never necessary	Necessary
Cost-effective	Yes	No
Early acceptable result	Yes	No

OSIKMFF = one-stage inverted-kite midline forehead flap; PMFF = paramedian forehead flap.

the OSIKMFF, the history of robustness spanning more than 2 500 years and the current detailed anatomic knowledge of the area, opting not to use the flap, and to rather use a paramedian forehead flap as a first choice, could be considered unethical. Patients should give full informed consent for an operation, and the onus of this ethical responsibility is on the treating surgeon. It is not inconceivable that patients who are well informed will choose the flap option with the best advantages and the least morbidity. We would do well to remember what our primary responsibility to our patients is in the Hippocratic Oath: *primum non nocere* – first do no harm.[16]

Conclusion

The one-stage forehead flap using the inverted-kite pedicle base modification is a useful technique, based on meticulously identified safe landmarks, robust blood supply, meticulous cadaver dissections and clinical experience over many years. It can also be of benefit in situations where patient follow-up is difficult, or in missionary surgery, where regular follow-up is not possible. The planning of the flap is made easier by identifying the central vein. Knowledge of the arterial and venous variations of the central forehead is essential, to increase one's understanding of potential variations in blood supply, and subsequent technical adjustments for flap refinements and safety. Based on the current evidence, and the experiences of many surgeons over 2 500 years, the paramedian forehead flap should be reserved for cases where the blood supply of the central forehead is compromised, and the midline forehead flap with one-stage inverted-kite inset should be the gold 'old' standard.

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