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The 'RITE' use of the Fricke flap in periorbital reconstruction

Abstract

Purpose To revisit an important but outmoded periorbital reconstructive technique.

We present cases to illustrate the usefulness of the Fricke flap and describe a method of rapid intraoperative tissue expansion (RITE), which can enhance the applicability and effectiveness of the Fricke flap. A comparison between those cases performed with and without adjunctive RITE was not made due to the low numbers available.

Methods A retrospective review of clinical cases.

Results A total of 20 cases in which the Fricke flap was used for periorbital reconstruction were reviewed. The mean patient age was 64.7 years; the male-to-female ratio was 1:1. The patient follow-up ranged from 1 to 8 years with a mean of 4.2 years. The most common cause (65%) of periorbital defect was excision of eyelid malignancy. Necrosis of the terminal segment of the flap requiring further surgical intervention occurred in 10% (2/20). In both of these cases, the surgeons were trainees, with the complications being due to poor surgical technique. In the first case, the flap base was too narrow and in the second case, the distal end of the flap was thinned excessively. The functional result was excellent in 10/20 (50%), good in 5/20 (25%), fair in 3/20 (15%), and poor in 2/20 (10%). The cosmetic result was excellent in 3/20 (15%), good in 12/20 (60%), fair in 3/20 (15%), and poor in 2/20 (10%).

Conclusion The Fricke flap is an important and, in selected cases, an indispensable technique in periorbital reconstruction. *Eye* (2005) **19**, 854–860. doi:10.1038/sj.eye.6701667; published online 17 September 2004

Keywords: Fricke; tissue; expansion; flap; periorbital; reconstruction

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Introduction

The Fricke flap is a temporally based monopedicle forehead transposition flap, first described by Jochim Fricke in 1829.1 It can be used in the reconstruction of large lower lid, upper lid, and lateral canthal defects or to bring vascularised tissue to anterior orbital defects. Although advocated by some surgeons as a 'last-resort' method of periorbital reconstruction, it is a valuable option for anterior lamella reconstruction of the lateral canthus, upper and lower lids.² It is particularly useful in the monocular patient in whom occlusion of the visual axis with techniques such as the Hughes or Cutler-Beard flaps would be unacceptable. It can be used for the reconstruction of an extensive lower eyelid defect, which is too large for a Hughes flap, avoiding the more extensive dissection involved in a Mustardé cheek rotation flap with the attendant risk of facial nerve trauma. It is particularly useful in lower lid defects involving the entire length of the lower lid but which are relatively short in their vertical dimension. These lesions do not lend themselves easily to repair with combined multiple skin flaps, and repairing these defects with a Mustardé flap results in a large triangulation defect and thus a significant loss of normal tissue. The effectiveness and applicability of the technique is potentially enhanced when used in combination with rapid intraoperative tissue expansion (RITE),³ a technique that has been described as causing a linear tissue expansion of 36%.⁴

We report our results using the Fricke flap in the reconstruction of upper or lower eyelid defects.

Methods

A retrospective analysis of the hospital records of 20 patients was undertaken. Being a

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retrospective review, the decision to use the Fricke flap in the reconstruction of these patients was a clinical one, on the basis of defect size and site, rather than a random or consecutive selection. The records included pre- and postoperative patient photographs. The results were classified in terms of function and cosmesis. The grading of the functional results was assessed according to the following criteria

- *Function:* Excellent: no ocular discomfort, no topical therapy required.
- *Good:* minimal functional disturbance, for example, minimal lagophthalmos not requiring therapy.
- *Fair:* functional disturbance requiring nonsurgical treatment, for example, lagophthalmos requiring lubricants to alleviate symptoms/signs.
- *Poor:* functional disturbance requiring surgical intervention.

Cosmesis: The grading of cosmesis was undertaken by an independent observer viewing the postoperative patient photographs. The observer was asked to classify postoperative cosmesis into four categories; excellent, good, fair, and poor, taking into consideration not only the appearance of the reconstructed eyelid but also the appearance of the eyebrow asymmetry. The asymmetry in eyebrow and eyelid heights were not measured but graded subjectively by an independent observer

Surgical technique

The flap donor site is situated immediately superior to the brow cilia with the maximal medial extent delineated by the supraorbital neurovascular bundle. The survival of the flap depends on its design, with the flap length as measured from the medial end of the defect to the base or rotation point of the flap. This width of the desired flap will determine the maximal length of the proposed flap in order that the tip of the flap has an adequate blood supply. The length : width ratio of the flap must not exceed of 4:1. The maximum width will depend on the surgeon's assessment of his/her ability to primarily close the resultant donor site and not leave a secondary defect.

The position of the base of the flap in relation to the defect is selected so as to balance the angle through which the proposed flap will need to be rotated with the required length of the flap. Placing the flap base more laterally in relation to the defect will reduce the angle through which the flap is rotated from its donor site to the defect but will increase the length of the flap. It is not desirable to exceed an angle of 90°. The flap is marked out, measuring the distance from the medial border of the defect to the base (pivotal point) using a piece of sterile gauze. The length of the flap should be

overestimated slightly as the flap will shorten as it is rotated. Quartering this distance will give the minimum required flap width. The medial end of the flap must mirror the medial end of the defect, avoiding a downward taper, which may be the natural tendency to facilitate donor site closure (Figure 1).

Using a no. 15 Bard Parker blade, a 15 mm skin incision is made temporally, through which a fine pair of Stevens



Figure 1 Illustration demonstrating the design and the transposition of the Fricke flap.

scissors are introduced and the plane between the subcutaneous tissue and the frontalis muscle is undermined. This avoids the risk of damage to the frontal branch of the facial nerve that runs along the undersurface of the superficial temporalis fascia (which is continuous with the galea), to innervate the frontalis 2 cm above the orbital rim.^{5,6} A no. 14 French Foley's catheter with the tip of the catheter distal to the 10 cm³ capacity balloon removed with heavy scissors is fed under the proposed flap. A 4.0 silk horizontal mattress suture encompassing the Foley's catheter is used to close the wound around the catheter. Normal saline is then injected into the balloon until there is blanching of the overlying skin (Figure 2). After 5 min the balloon is deflated for 1-2 min and then reinflated for a further 5 min.⁴ The balloon is then deflated and the silk suture and the Foley catheter removed.

Using a Bard Parker blade and Stevens scissors, the Fricke flap, consisting of skin and subcutaneous tissue, is dissected from the underlying frontalis and orbicularis oculi muscles and transposed into the recipient site. Interrupted buried subcutaneous 5.0 Vicryl sutures are used to anchor the flap and 6.0 Novafil sutures are used for skin closure. It is not necessary to anchor the flap to the underlying tissue. The donor site defect is closed directly with interrupted buried subcutaneous 5.0 Vicryl sutures and a subcuticular 5.0 Nylon suture. A light pressure dressing is placed for 48 h and the skin sutures are removed after 7-10 days. The patient is instructed to perform wound massage commencing after 2 weeks. The brow is also massaged in a downward direction. The patient performs wound massage four times per day for 4 min at each sitting for a period of 8 weeks. The patients are then reviewed again at 4 and 8 weeks postoperatively. The base of the flap is divided and refashioned after a period of 6-8 weeks.



Figure 2 Extensive left lower eyelid Mohs surgery defect. 'RITE' is being performed. The Foley catheter is inflated beneath the Fricke flap.

Results

We report the results of 20 patients in whom a Fricke flap was used in periorbital reconstruction. Of these 'RITE' was used in four cases. The age range was 48–84 years with a mean of 64.7 years. The range of follow-up was 2–8 years with a mean follow-up of 4.2 years. Two patients had ipsilateral monocular vision precluding the use of flaps that obstruct the visual axis.

Two of the Fricke flaps were complicated by necrosis of the terminal segment resulting in poor functional outcomes. In the first case, the width of the base of the

Male patient Female patient		10/20 (50%) 10/20 (50%)
Defect site	Defect: Lower lid Defect: Lower lid and cheek Defect: Upper lid	10/20 (50%) 4/20 (20%) 6/20 (30%)
Aetiology of defect	Post excision of eyelid malignancy	13/20 (65%)
	Paranasal sinus fistula: post radiotherapy	3/20 (15%)
	Tissue defect post trauma	3/20 (15%)
	Post thermal injury	1/20 (5%)
Procedures used in combination with Fricke flap	Hughes tarsoconjunctival flap	4/20 (20%)
I	Posterior lamella hard palate mucosal graft	7/20 (35%)
	Periosteal strip	4/20 (20%)
	Full-thickness skin graft	5/20 (25%)
	Rhomboid flap	3/20 (15%)
	Radial forearm free flap	1/20 (5%)
	Dermis fat graft (for volume replacement)	3/20 (15%)
	No associated procedure	2/20 (10%)

flap was too narrow to support the distal segment, and in the second case the distal third of the flap was thinned excessively (all subcutaneous tissue had been removed). In these two patients, a subsequent reconstruction was required (one patient required a Mustardé cheek rotation flap and the other patient a Hughes procedure and FTSG). Two patients having undergone upper lid reconstruction had residual lagophthalmos measuring 2 and 3 mm, respectively. One patient was managed with topical lubricants and one patient required a lateral tarsorrhaphy. One patient developed a cicatricial lower lid ectropion that was managed with a lateral tarsal strip and FTSG.

All patients developed asymmetry of the eyebrows that improved over time with downward massage.

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Functional results	Excellent	Good	Fair	Poor
	9/20 (45%)	5/20 (25%)	2/20 (10%)	2/20 (10%)
Cosmetic	Excellent	Good	Fair	Poor
results	3/20 (15%)	12/20 (60%)	3/20 (15%)	2/20 (10%)

Illustrative Cases

Case 1

In this case, a 62-years-old male patient was referred to the oculoplastic service for the management of a severe right lower eyelid cicatricial ectropion following a maxillectomy and postoperative radiotherapy (Figure 3). There was considerable atrophy of the lower eyelid preaponeurotic fat and subcutaneous tissue of the adjacent cheek. An incision was made at the lower border of the tarsus and the eyelid was mobilised from the underlying scar tissue. An abdominal dermis fat graft was placed into the cheek and the Fricke flap positioned into the inferior eyelid defect overlying the dermis fat graft. 'RITE' was used. The flap was divided after a period of 8 weeks. Postoperatively, he was left with a mild residual cicatricial ectropion. This was managed successfully with an FTSG from his upper inner arm and a lateral tarsal strip procedure. At 2 years following these procedures, he was left with a good functional and cosmetic result albeit with 2 mm of lower eyelid retraction (Figure 4).

Case 2

In this case, an extensive lower lid Mohs surgery defect of the left lower eyelid in a 59-years-old male patient was reconstructed with a Fricke flap used in conjunction with an HPMG (Figure 5). 'RITE' was used. A maximal Hughes tarsoconjunctival flap and an FTSG as an alternative reconstructive option,⁷ even



Figure 3 Severe right lower eyelid cicatricial ectropion following a maxillectomy and postoperative radiotherapy.

given the trend towards early flap division,⁸ was not desirable in this patient who was densely amblyopic in his right eye. The flap was divided after a period of 6 weeks. Postoperatively, a good functional and cosmetic result was achieved (Figure 6).



Figure 4 Postoperative appearance 2 years following a reconstruction of the cicatricial ectropion with the use of a Fricke flap, a dermis fat graft, and full-thickness skin grafts. 'RITE' was used.



Figure 5 Extensive left lower lid Mohs surgery defect.



Figure 6 Postoperative appearance following a reconstruction with a Fricke flap used in conjunction with an HPMG. 'RITE' was used.

Case 3

In this case, a 27-year-old male patient suffered severe periocular trauma from multiple dog bites. He had suffered an epileptic seizure and while unconscious had been set upon by his pet terrier. There was extensive tissue loss (Figure 7a and b). His left lower eyelid reconstruction was achieved with the use of a Fricke flap combined with FTSGs and direct closure (Figure 8). In this case 'RITE' was not used. His flap was divided after a period of 8 weeks. Postoperatively, a fair functional and cosmetic result was achieved (Figure 9). The patient refused to comply with postoperative wound care and massage and declined any further surgical intervention, which could have yielded a superior cosmetic result.

Discussion

The use of a temporally based monopedicle flaps allows the reconstruction of the anterior lamella of the upper or lower lid and lateral canthal areas without occlusion of the visual axis. Being a vascularised flap, it can support a free graft for the reconstruction of the posterior lamella. A random cutaneous flap should obey a ratio of 1:2 for width to length to ensure a good vascular supply to the



Figure 7 (a, b) Severe periocular trauma with extensive tissue loss following multiple dog bites.



Figure 8 Immediate postoperative appearance following reconstruction of the left lower eyelid the use of a Fricke flap combined with direct closure and FTSGs. In this case 'RITE' was not used.



Figure 9 Postoperative appearance 3 weeks following division of his Fricke flap.

tip of the flap.⁹ If the Fricke flap is fashioned to include the frontal branch of the superficial temporal artery as an axial blood supply the ratio can be extended greatly.¹⁰ Rotation flaps can be rotated through an angle of up to 90° .¹¹ The smaller the angle of rotation, the lower the risk of causing undue tension on the base of the flap, which can compromise the blood supply to the flap.

The advantages and disadvantages of the Fricke flap are listed in Table 1.

We feel there are a number of periorbital defects in which the Fricke flap plays an important and, in certain cases, indispensable role. The Fricke flap has a definite role in the monocular patient with an extensive lower eyelid defect involving the full vertical height of the eyelid. Alternatives include a Mustardé cheek rotation flap or a nasojugal flap. The Mustardé flap carries a higher risk of facial nerve damage with a greater area of dissection over the more proximal portion of the facial



Table 1 Advantages and disadvantages of the Fricke flap

Advantages	Disadvantages
Can be used to reconstruct large upper, lower and lateral canthal skin defects	A two-stage procedure
Avoids occlusion of the visual axis	Forehead skin is thicker than eyelid skin
Vascularised flap able to support free posterior lamella graft	Raises the level of the eyebrow

nerve and in an area where the nerve travels more superficially (over the zygomatic arch), whereas the Fricke flap is elevated in the easily identified plane between the subcutaneous tissue and the frontalis muscle/galea avoiding damage to the frontal branch and the zygomatic branches of the facial nerve that innervate the orbicularis from its deep surface.^{5,6} The nasojugal flap provides a smaller flap and can result in a distorted nostril. It is associated with a greater degree of postoperative lymphoedema.

The effectiveness and applicability of the Fricke flap can be increased with adjuvant use of tissue expansion. It may be hypothesised that it is the skin's viscoelastic properties of creep and stress relaxation are the basis of RITE. The term 'stress relaxation' refers to the property that once a force has been used to stretch skin, a decreasing load is needed to maintain that stretch over time. Creep refers to the increasing rate of skin extension when a constant load is applied over time.^{12–14}

Advantages of tissue expansion include a smaller defect at the flap donor site, less wound-closure tension at the donor and recipient sites reducing the risk of wound scarring, and less displacement of adjacent structures (for example, brow elevation at the harvest site and cicatricial ectropion at the donor site).

Chronic tissue expansion is well described and has an established role in many areas of reconstructive surgery including oculoplastics.3 It has the disadvantage of necessitating a two-stage procedure (three stages when used in combination with the Fricke flap) and requires planning well in advance of the reconstructive procedure, which is usually not possible in the setting of trauma or Mohs micrographic surgery. Rapid intraoperative tissue expansion provides an alternative to chronic tissue expansion. While it will not provide the same amount of tissue expansion, it has been shown to be an effective method in the creation of additional local tissue for reconstructive purposes.^{3,4,7,15} Foster *et al*⁴ in a case series study on the use of RITE in eyelid reconstruction reported an average reduction of 36% in the linear extent of eyelid margin defects. When applied with the Fricke flap, RITE allows more effective use of the Fricke flap and its application to a wider range of periocular tissue defects.

The histological changes underlying the tissue expansion achieved by RITE are not well understood. Initially, acute expansion was hypothesised to be due to rupture of the interlinking of dermal collagen allowing the fibres to realign in a direction parallel to the force that stretches them. Histopathological studies did not confirm this theory,^{12–14} and there are probably a number of factors involved, including altering of the tissue surrounding the expander by compression, and by cell and interstitial space dehydration.

Although in the series of patients presented here, RITE was only utilised in four patients, the purpose of this paper is to revisit the Fricke flap as a useful periorbital reconstructive technique, and emphasise that its effectiveness may be enhanced by the use of rapid intraoperative tissue expansion. RITE is ideal for use in the periorbital region. The facial skeleton and frontal bones form a rigid platform to ensure the force from an enlarging expander is transmitted to the overlying tissues. Given the cosmetic impact of a periorbital reconstruction and the paucity of adjacent recruitable tissue, it is an important technique that can be used in combination with most periorbital flaps to enhance their efficacy.

It has been stated that RITE has no more effect than an equivalent amount of undermining necessary to place the expander and subsequent undermining caused by inflation of the expander.^{3,16} Forster *et al* hypothesise that the 'forces generated in RITE are multidirectional and a graded process according to the amount of expansion created. This more blunt and multidirectional process may be useful in regions where direct undermining could focally injure fragile anatomy.' Also direct undermining will disrupt some of the tissue blood supply rather than the temporary occlusion of RITE.⁴

Conclusion

We feel that RITE is an important adjunct in the harvesting of periorbital flaps. Whether a result of changes in tissue hydration or multidirectional blunt dissection of the expanding balloon or a combination of both, Forster *et al* have reported a 36% reduction in the linear extent of lid margin defects when using intraoperative tissue expansion.

Although out of favour with many oculoplastic surgeons, from this case series it can be seen that the Fricke flap has a wide application in periorbital reconstruction and can give good functional and cosmetic results. It is likely that its application to various periorbital defects may be enhanced by using 'RITE'.

References

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- Fricke JCG. Die Bildung neuer Augenlider (Blepharoplastik) nach Zerstörungen und dadurch hervorgebrachten Auswärtswendungen derselben. Pethes und Bessler: Hamburg, 1829.
- 2 McCord D. Upper Eyelid Reconstruction. In: McCord CD (Ed). Eyelid Surgery. Principles and Techniques 1st ed. Lippencott-Raven: Philadelphia; 1995, pp 252–269.
- 3 Baker SR, Swanson NA. Rapid intraoperative tissue expansion in reconstruction of the head and neck. *Arch Otolaryngol Head Neck Surg* 1990; **116**: 1431–1434.
- 4 Foster JA, Scheiner AJ, Wulc AE, Wallace IB, Greenbaum SS. Intraoperative tissue expansion in eyelid reconstruction. *Ophthalmology* 1998; **105**: 170–175.
- 5 Tse DT, Goodwin J, Johnson T, Gilberg S, Meldrum M. Use of galeal or pericranial flaps for the reconstruction of orbital and eyelid defects. *Arch Opthalmol* 1997; **15**: 932–937.
- 6 Leibman EP, Webster RC, Berger AS, Della Vecchia M. The frontalis nerve in the temporal brow lift. *Arch Otolaryngol* 1982; 108: 232–235.
- 7 Ehlert TK, Thomas JR. Rapid intraoperative tissue expansion for closure of facial defects. Arch Otolarngol Head and Neck Surg 1991; 117: 1043–1049.
- 8 Maloof A, Ng SG, Leatherbarrow B. The maximal Hughes procedure. *Ophthalmic Plastic Reconstr Surg* 2001; 17: 96–102.

- 9 Shumrick KA, Smith TL. The anatomic basis for the design of forehead flaps in the in nasal reconstruction. *Arch Otolaryngol Head Neck Surg* 1992; **118**: 373–379.
- 10 Yeatts RP, Newsom RW, Matthews BL. Doppler-assisted pedicle flaps in eyelid and periorbital reconstruction. *Arch Ophthalmol* 1996; **114**: 1149–1152.
- Codner MA and McCord CD. Reconstructive Flaps. In: McCord CD (Ed). *Eyelid Surgery. Principles and Techniques* 1st ed. Lippencott-Raven: Philadelphia; 1995, pp 23–29.
- 12 Belkoff SM, Naylor EC, Walshaw R, Lanigan E, Colony L, Haut RC. Effects of subcutaneous expansion on the mechanical properties of porcine skin. J Surg Res 1995; 58: 117–123.
- 13 Marks MW, Mackenzie JR, Burney RE, Knight PR, Anderson SH. Response of random skin flaps to rapid expansion. J Trauma 1985; 25: 947–952.
- 14 Guida RA, Cohen JI, Cook TA, Swanson NA, Burgeson R, Johnson TM. Assessment of survival and microscopic changes in porcine skin flaps undergoing immediate intraoperative tissue expansion. *Otolaryngol Head Neck Surg* 1993; **109**: 926–932.
- 15 Machida BK, Liu-Shindo M, Sasaki GH, Rice DH, Chandrasoma P. Immediate versus chronic tissue expansion. *Ann Plast Surg* 1991; 26: 227–231; discussion 232.
- 16 McNab AA, Martin P, Benger R, O'Donnell B, Kourt G. A prospective randomized study comparing division of the pedicle of modified Hughes flaps at two or four weeks. *Ophthalmic Plast Reconstr Sur* 2001; **17**(5): 317–319.