

The Role of Advancement Flaps in Peri-ocular Reconstructive Surgery

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Abstract

Introduction: The advancement flap is a method of mobilisation of tissue in a linear direction so as to achieve closure of a primary defect. This technique has been used extensively in the field of ophthalmic reconstruction and has undergone modifications to suit the needs of the surgery. **Methods:** The PubMed database was used to search for articles using the keywords “periocular” and “advancement flaps” and we included the relevant cross references for other articles, books and chapters on the different types of advancement flaps used for peri-ocular reconstructive surgery. We present a summary of our findings in this review. **Results:** We present a range of different types of advancement flaps which include the single advancement flaps, double advancement flaps and Burow’s triangle flaps. We also discuss the use of segmental artery based flap, the island pedicle advancement flap, V-Y advancement flaps and sliding tarsal flaps to repair tissue defects of the peri-orbital region. The benefits and limitations of each of these techniques are highlighted. **Conclusion:** The advancement flap and its modifications are practical and simple techniques that add to the armamentarium of reconstructive procedures for the ophthalmic surgeon in the management of peri-ocular defects.

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Introduction

The advancement flap is a modality of skin defect closure via mobilisation of tissue along a linear direction. It is one of the most versatile flaps used commonly in many surgical disciplines including ophthalmology. This technique may be used to close a variety of defects of various sizes and shapes around the eyelids, eyebrows, glabella, forehead, temple, medial and lateral cathal regions. The peri-orbital region is an area where advancement flaps, either random (with cutaneous or musculo-cutaneous vasculature) or a pedicled (with a segmental artery), will survive well because of the rich blood supply in the head and neck.

Over the years, modifications to the basic advancement flap techniques have been described that included different methods and patterns of flap creation and the use of multiple advancement flaps. The factors that determine the type of flap reconstruction include the depth, size and location of the tissue defect, the elasticity of adjacent tissues and the relations of the defect to adjacent anatomical landmarks such as the eyebrow and hairline. We performed

a literature review of the use of advancement flaps in the field of ophthalmic reconstructive surgery to highlight its functions and limitations.

Single Advancement Flap

The most basic type of advancement flap, the single advancement flap, is different from a primary closure in that additional incisions are made parallel to each other and tangential to the primary defect. This is a random flap that allows limited soft tissue movement to close a defect. Compared to simple undermining alone, the added mobility of the advancement flap is contributed by stretching of the flap and the excision of Burow’s triangles at the proximal edge of the flap to remove redundant tissues or standing cones. When dealing with hair-bearing areas like the eyebrows however, care must be taken to undermine beneath the hair follicles so as to avoid damaging them.¹

In creating the flap, care should also be taken to ensure that the thickness of the flap matches that of the primary defect and should include a thin layer of fat to maintain

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vascular sufficiency. In some cases, the inclusion of an intact vessel within the flap may be necessary to further secure blood supply although this is usually not required for surgeries in the peri-ocular area because of the rich blood supply in the area. In general, the length-to-width ratio of the flap should be around 3:1 in order to ensure vascular sufficiency and to minimise distal end necrosis.²

The lower eyelids may be prone to distortion and malpositioning from unopposed tractional forces, cicatricial and gravitational forces. Harris et al³ described the use of deep anchoring sutures to secure different types of advancement flaps to the underlying periosteum in order to minimise eyelid and canthal dystopia.

The main limitation of the single advancement flap is the development of standing cones of redundant tissues which necessitates their removal either by excision, with the attendant risk of further scar formation, or by sewing them out using the “rule of halves” which may not be always possible. Moody et al⁴ described a modification to the basic advancement flap in order to prevent the formation of standing cones by making a curvilinear incision along the limb of the flap to redistribute the redundant tissue. However, a curvilinear flap narrows the flap pedicle and limits additional tissue movement gained from standing cone excision. It may not be suitable in large flap reconstructions as it causes more flap stretching and in flaps of patients with poor blood supply such as smokers or diabetics.

It is advantageous to site the incisions correctly so that the final suture lines are placed along skin tension lines, the borders of cosmetic units such as forehead-scalp junctions or rhytides to camouflage them.²

Double Advancement Flaps: The O-I and A-T Flaps

The O-I Flap

This double advancement flaps technique involves the placement of 2 single advancement flaps adjacent to each other and then bringing together their distal edges. This allows for additional tissue movement but at the cost of creating 2 additional suture lines. The “O” shaped defect between the adjacent flaps becomes an “I” shaped closure (Fig. 1).

The O-I flap is particularly useful in the repair of lower eyelid defects, as it does not shorten the anterior lamella vertically like a Z-plasty reconstruction. This flap reconstruction can avoid the problems of lower eyelid retraction, inferior scleral show, ectropion and exposure keratopathy as it recruits tissue horizontally from the medial and lateral aspects of the lower eyelid to provide additional horizontal support. Good cosmesis may be achieved as most of the incisions are made along the skin tension lines, making the resulting scars inconspicuous.

The A-T Flap

The A-T flap is fashioned by the placement of an incision along the base of an imaginary triangular or circular defect and then apposing the basal tips of the triangle with the midpoint of the triangle base to form an inverted T shape wound (Fig. 2). Standing cones of tissue redundancies from both vertexes of the base may need to be excised or reconstructed with curvilinear incisions as described earlier.⁵ This flap is especially useful when tissue recruitment from one border of a defect (such as the scalp) is undesirable. The base of the flap is thus placed along the wound edge to be preserved.

The double advancement flaps are suitable for the reconstruction of forehead and eyebrow defects as the resulting scars may be hidden within the eyebrow hairs or normal anatomical borders such as the hairline.

The Burow’s Triangle Flap

The Burow’s triangle flap is a type of advancement flap created by incising along one side of the base of a defect only (like a half A-T flap) and undermining the surrounding soft tissue to enable the advancement of the flap into the defect. A second Burow’s triangle created from this single flap advancement at the end of the flap distal to the primary defect may then be excised (Fig. 3). The Burow’s triangle flap has the advantage of having a wide, well vascularised pedicle and the ability to position the standing cone in and subsequently remove it from a site that is away from the primary defect, or other structures which are to be avoided.¹ The disadvantages of this technique include limited flap mobilisation offered by a single flap (unlike the double advancement flaps like the A-T plasty) and the formation of a larger second Burow’s triangle. The latter can be minimised by lengthening the flap incision.

Wang et al⁶ recently reported this flap reconstruction technique to close a lateral forehead defect. A Burow’s triangle is resected from the superior border of the defect followed by an arched incision extending from the base of the defect infero-laterally along the temple followed by the removal of second Burow’s triangle lateral to the outer canthus. This technique utilises the lax temple soft tissue to achieve closure of the defect without the need for extensive undermining the temporal area thus minimising potential injury to the frontal branch of the facial nerve traversing this anatomical site. It is a random-axis flap with slight rotational aspect and heals with good cosmesis.

Kouba et al⁷ also described a modified Burow’s triangular flap (named as “J-plasty”) that is useful in the repair of malar cheek defects near the orbital rim. The main advantage of this flap is that there is very little tension placed on the lower eyelid and places the incision lines within the border of a cosmetic subunit.⁷

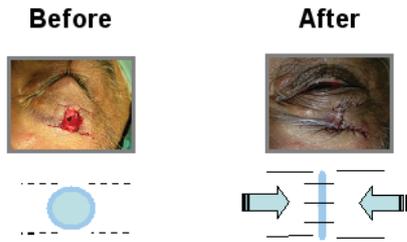


Fig. 1. An O-I flap. Parallel incision lines (dashed lines) are made on either side of the “O” shaped defect (blue outline). Two advancement flaps are then mobilised (in the direction of the arrows) to form an “I” shaped wound to close it.

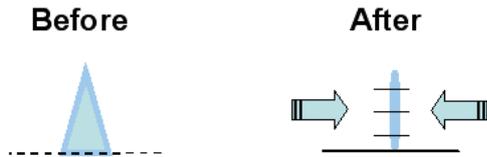


Fig. 2. The A-T flap. An “A” shaped primary defect (blue outline) with additional parallel incision lines (dashed lines) made on the bases of the triangle. Two advancement flaps were then created and apposed towards the midline of the base of the triangle to form an inverted “T” shaped wound.

The Segmental Artery Based Advancement Flap

An upper eyelid cutaneous advancement flap based on the superior palpebral artery is fashioned and used to close small medial canthal defects.⁸ This technique confers the advantage of excellent flap vascularity (and hence survival), skin colour and texture match and a creation of donor site hidden within the upper eyelid skin crease.

The Island Pedicle Advancement Flap

The island pedicle advancement flap is extremely versatile and may be used in the closure of defects in difficult areas such as the medial canthal region that pose special challenges for the surgeon because of the many functional and cosmetic considerations. Essentially, the island pedicle advancement flap is different from the other types of advancement flaps in that it derives its perfusion solely from the subcutaneous pedicle due to the absence of any dermal or epidermal attachments to its site of origin. The location of the base of the pedicle relative to the distal flap is often used to describe the flap; hence, a superiorly based flap has the base of the pedicle located superior to the flap.

The island pedicle advancement flap is created by making 2 incisions that are extended to 2 separate points along the edges of the defect from a point located away from the primary defect (Fig. 4).⁹ These 2 incisions should be of an angle of about 30 degrees so that the secondary defect could be closed without the formation of standing cones.⁹ These incisions should also be made to form an island of tissue flap roughly 2 to 3 times the diameter of the primary defect, and width that is equal to the diameter of the wound.¹⁰ The thickness of the flap should match the depth of the primary defect. Sometimes, the flap edges may be

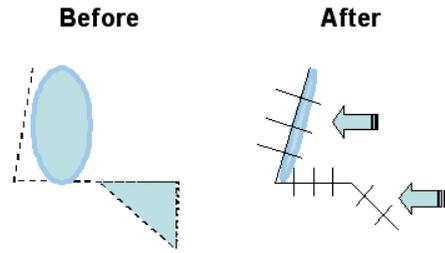


Fig. 3. Burows triangle flaps. In this example, the primary defect is closed with the help of excision of 2 Burow triangles. Added incisions were made along the base of the triangular defects (dashed lines) to allow for more movement of the advancement flap (in the direction of the arrows).

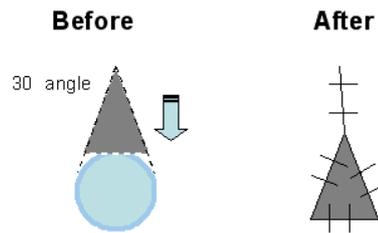


Fig. 4. The island pedicle flap. Two incisions (dashed lines) angled at about 30 degrees are made from a point distal to the defect to create a triangular island flap (shaded grey). The flap is undermined and advanced in the direction of the arrow to cover the defect while the second defect (from the island flap dissection) is closed.

thinned in order to improve the wound apposition and contour although this should probably be avoided in patients with a tenuous blood supply such as smokers or diabetics. As with the other advancement flaps, it is crucial to relieve excessive tension on the flaps by adequate undermining of the surrounding soft tissue.

The island pedicle advancement flap has several advantages over the other advancement flaps with epidermal or dermal attachments. The greater mobility of the soft tissue with this technique permits advancement of the flap over greater distances. The size of primary defect that can be covered by an island pedicle advancement flap is also larger because of the central location of the pedicle. Finally, the use of the island pedicle advancement flap often does not result in the creation of standing cones. The island pedicle flap may be suitable for the reconstruction of defects of the upper eyelid, glabella, lateral canthal region, cheek, nose and nasolabial fold.⁹

The V-Y Advancement Flaps

The V-Y advancement flap is formed by making initial incisions in a V-shaped configuration and advancing the broad base of the V into the primary defect. The resulting deficit from the secondary wound is closed primarily to form a Y-shaped configuration. These conspicuous geometric suture lines can sometimes be difficult to conceal. Esser¹¹ was the first to describe the use of V-Y advancement flaps and subsequently, several other authors reported its use in peri-ocular reconstructive surgery.¹²⁻¹⁴

In creation of a flap, it is important to create one of an adequate depth. The initial incisions made should be down at least to the level of subcutaneous fat to ensure adequate flap mobility and perfusion. The cross-sectional area of the pedicle should be roughly equal to the area of the overlying skin in order to preserve perfusion to the greatest extent. However, to enable greater tissue movement, the pedicle may be narrowed to a certain extent, supported by the rich blood supply of the area around the eye.

Combination V-Y Advancement Flaps

The reconstruction of the medial canthal area poses specific challenges to the ophthalmic plastic and reconstructive surgeon. It is an anatomically distinct area with many functional and aesthetic components. It contains the lacrimal drainage system, bony attachments of eyelids, and orbital neurovascular structures such as the supra-trochlear neurovascular bundle. In addition, its complicated 3-dimensional contours contribute further to complexity of its reconstruction. The options for medial canthal reconstruction include closure with skin grafts, frontal flaps or V-Y advancement flaps.

Yildirim et al¹⁵ described the combined use of the nasolabial V-Y advancement and glabellar V-Y advancement flaps for the reconstruction of large sized medial canthal defects of up to 3 by 3 cm with good functional and cosmetic outcomes. Onishi et al¹⁶ reported a reconstruction technique for large medial canthal defect closure with a glabellar flap following basal cell carcinoma excision and subsequent closure of the glabellar flap donor site using a Rintala flap. The V-Y advancement flaps enable wound closure in this region with minimal tension at all levels, avoiding tissue contracture often seen with full thickness skin grafting. Furthermore, the V-Y advancement flap utilises local tissue and has good skin colour and texture match to achieve better cosmesis.

The Sliding Tarsal Flaps

Sometimes, the advancement flap technique may be used for the reconstruction of deeper structures like the posterior lamella. deSousa et al¹⁷ described a novel technique to reconstruct full thickness lower eyelid defects following Mohs micrographic resection that involves making an oblique incision in the residual tarsus to create medial and lateral tarsal flaps that were then obliquely overlapped to tighten the eyelid and reform the tarsus.

Conclusion

Advancement flap techniques have been used extensively by the ophthalmic reconstructive surgeon in dealing with peri-ocular wound defect closure with good results. Some of the techniques have undergone modifications and refinements to suit the surgical needs. The advancement

flap technique has several advantages that include a relatively short operative time, a single staged procedure, simplicity and the avoidance of complex non-linear scars traversing skin tension lines. Most importantly, the good vascular supply of the flap from the cutaneous, musculo-cutaneous or segmental artery enables good flap survival and the placement of other free grafts such as hard palate or cartilage to reconstruct the deeper tissues such as the posterior lamella of the eyelids. The technique also employs the use of local tissues that achieve excellent cosmetic result due to matching of skin colour, texture and thickness.

Vascular insufficiency of the advancement flap may be caused by undermining in the wrong tissue plane, excessive tension on the flap, haemorrhage, infection or compression of the pedicle could result in flap failure. The wound closure in an advancement flap should not be under tension to reduce the risk of wound edge necrosis, wound dehiscence and scar widening. The use of advancement flaps may be limited at sites with relatively tight skin and little tissue mobility such as the nose tip where other reconstructive methods such as the bilobed flap may be utilised.

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