Oculoplastic Surgery

A Practical Guide to Common Disorders

Essam A. El Toukhy
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Essam A. El Toukhy
Cairo University, Dokki, Cario, Egypt

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Basics of Oculoplastic Procedures

Ahmed G. El Sharkawy[1], Rania A. Ahmed[2] ✉ and Ali Odadi[3]
(1) Department of Plastic Surgery, Cairo University, Cairo, Egypt
(2) Department of Ophthalmology, Cairo University, Cairo, Egypt
(3) Odadi Cosmetic Eye Center, Abha, Saudi Arabia

✉ **Rania A. Ahmed**
Email: ransalam@gmail.com

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Introduction

Oculoplastic surgery is the subspecialty that combines the art and principles of plastic and reconstructive surgery with the delicacy and precision of ophthalmic surgery. An oculoplastic surgeon should be aware of the principles of both worlds as well as surgical skills to get optimum cosmetic and functional results while protecting the globe and the patient's vision. This chapter will focus on these basic surgical principles.

Wound Healing

Wound healing is a natural response to tissue injury. A complex cascade of cellular and vascular events is involved to restore the tissue structure, ensure resurfacing and restoration of tensile strength of the injured skin. This process comprises mainly 3 phases that usually overlap.

The inflammatory phase is the first response to injury where hemostasis occurs through blood vessels constriction and formation of platelets clot. Once homeostasis is achieved, the blood vessels dilate allowing inflammatory cells, antibodies and enzymes to debride the injured site, promote wound healing and fight infection. At this stage, the patient experiences the signs of inflammation such as pain, swelling, redness and hotness.

The proliferation phase is the stage where a new healthy granulation tissue appears to restore the tissue defect. This requires a good blood supply in order to provide oxygen and nutrients. Mesenchymal cells in the injured area change into fibroblasts that secrete collagen and growth factors that induce angiogenesis. Both form the granulation tissue which is the base for the scar tissue development. The granulation tissue is soft, fragile and bleeds easily. It is pinkish-red if the wound is healthy and dark or yellow in cases of poor vascular supply or infection. At this stage, epithelial cells at the wound edge proliferate, differentiate and migrate to cover the surface area.

The remodeling stage starts after 3 weeks and continues for 6–12 months. This is the stage where the final scar tissue is formed, and the wound gets mature. During this phase, the dermal tissues are overgrown to enhance their tensile strength and non-functional fibroblasts are replaced by functional ones. Cellular activity declines with time and the number of blood vessels in the affected area decreases.

During healing, the tensile strength of the wound gradually increases. Sutures support the wound and take some of the strain over it till the time of their removal. The presence of marked wound tension causes bad wound stretch and unsightly scar.

Scar behavior varies with age, site, skin type and the wound direction. Scars in children tend to be red for a longer period of time and they can become hypertrophic. With aging, the scar settles rapidly, and they tend to be hidden within the existing wrinkles. Suture marks are more prominent in coarse oily skin.

These factors are unavoidable and may jeopardize the outcome. However, proper surgical technique, combating infection and hematoma as well as improving the patient's general condition with special stress on avoiding smoking could provide the best possible results.

Skin incision placement

In order to gain a cosmetically accepted scar, incisions should be placed in natural lines, natural junctional lines or in areas where the scar will not be visible.

The natural creases or wrinkle lines provide a good camouflage for the placed scar. These creases occur perpendicular to the direction of muscles creating them. The upper lid crease incision and the lateral canthal crow's feet are good examples for such placements in the periocular region.

Skin incisions placed near anatomic structures such as eye lashes (in subciliary incision) and eye brow are usually less visible. However, it should be noted that in cases of the latter, the skin incision should be made parallel to the hair follicles to avoid their destruction with the result of an unsightly scar.

Wound closure

A surgical wound closure is usually preplanned to achieve the best cosmetic outcome. In presence of tension on wound edges, subdermal tissue undermining can be done to create small advancing flaps to relieve the tension. The wound edges should be everted to avoid a depressed scar after healing. Hence, sutures should be taken perpendicular to the wound line, equally distanced from the edges with equal bite depth.

However, in cases of trauma with irregular wounds, time should be invested to identify the wound main landmarks and fit the fresh parts of the tissue jigsaw. Although Z-plasty can improve the appearance of scars, its use should be deferred for subsequent scar revisions after proper evaluation .

In cases of suspected tissue defects, the viable tissues should be replaced in their correct places so that the actual defect can be properly assessed. According to the level of expertise of the surgeon, it can be primarily managed or deferred.

Suture material

Sutures ’ main role is to support the tissues throughout the critical period of wound healing . In oculoplastic procedures, there are used for deep closure or fixation as well as skin closure. Other skin closure techniques such as staples and tissue adhesives have no or limited role in closing wounds in the periocular region due to its thin mobile skin. The choice of the suture material depends on the surgeon’s preference and experience as well as the wound condition.

Suture materials are now routinely swaged into the surgical needles and they are mainly classified into;

Absorbable or non-absorbable

Monofilament or multifilament

Natural, synthetic or metal wires.

Absorbable Sutures

They degrade naturally overtime from 5 days to 40 days. They can be left in situ yet the surgeon should consider the extent of tissue reaction induced by them. Gut (collagen), chromic gut, polyglycolic acid (Vicryl) and polycaprolate (Dexon) are common absorbable sutures used in oculoplastic surgery .

Natural absorbable sutures like collagen and chromic gut are absorbed through enzymatic degradation which is unpredictable and can affect the process of wound healing . Synthetic sutures like Polyglactin are degraded by hydrolysis which is more predictable and takes a longer period.

Non-absorbable Sutures

They are permanent sutures that need to be removed if used to close the skin. Examples include Prolene, nylon and polyester.

Monofilament Versus Polyfilament

Monofilament sutures are formed of a single strand making it easier to pass through tissues and are less organism inviting. However, they have a memory making it a bit of a challenge to handle and they can be crushed rendering them weaker. Polyprolene (Prolene) is an example of monofilament suture .

Polyfilament sutures , as the name implies, are formed of multiple filaments that are either braided or twisted. They show higher tensile strength and are easier to handle due to their pliability. They could also be coated to enhance suture knotting and reduce reactions in the tissues. These sutures may invite infection due to their increased capillarity, however, antimicrobial coated sutures are available. Silk and polyglactin are examples of polyfilament sutures .

Natural Versus Synthetic

Natural suture materials include silk, gut and chromic gut while synthetic include prolene, polyester, polyglycolic acid and polytetrafluoroethylene (Gore-Tex). Metal sutures are usually used for repair of telecanthus and certain types of fractures.

The common suture materials used in oculoplastic surgeries and their characteristics are summarized in Table 1.

Table 1 Common suture materials and their characteristics

Suture	Nature	Characteristics	Degradation	Color	Uses
Silk	Natural	Multifilament	2 years	Black	Skin closure Lid margin repair
Plain gut	Natural	Monofilament	7–10 days	Straw colored	Skin and conjunctiva closure
Chromic gut	Natural	Monofilament	2–3 weeks	Brown	Deep wound closure, tarsus closure
Nylon	Synthetic	Monofilament	Non absorbable	Black	Skin closure
Prolene	Synthetic	Monofilament	Non absorbable	Blue	Skin closure Permanent deep suturing Used in cases of potential infection
Polyglactin	Synthetic	Multifilament	3–4 weeks	Violet	Deep wounds closure, anchoring sutures , tarsus sutures
Polydioxanone (PDS)	Synthetic	Monofilament	4–6 weeks	White or violet	Deep suspension sutures
Gore-Tex	Synthetic	Monofilament	Non absorbable	White	Frontalis suspension , brow pexy
Polyester	Synthetic	Multifilament	Non absorbable	White or green	Deep permanent sutures

Needles

Needle penetration and the subsequent suture passage induce an additional injury to the existing wound, hence affecting its healing course. Subsequently, proper needle selection is critical. The surgical needle is formed of a point, a body and a swaged end where the suture is attached. Needles vary in shape, tip and size.

The body forms most of the needle length. It is the part interacting with the needle holder and is responsible for transmitting the penetrating force to the needle point. It can be either straight, curved, half curved or compound curved.

Needles used for oculoplastic surgeries are curved as they have a predictable path through the tissues and require less space for maneuvering. The curve is described as a proportion of a full circle (Fig. 1) and is available in different sizes. The 3/8 circle needles are used for general suturing purposes while the 1/2 circle needles are used for suturing in deep confined spaces such as attaching the lateral tarsal strip to the periosteum and closure of posterior flaps in external dacryocystorhinostomy .

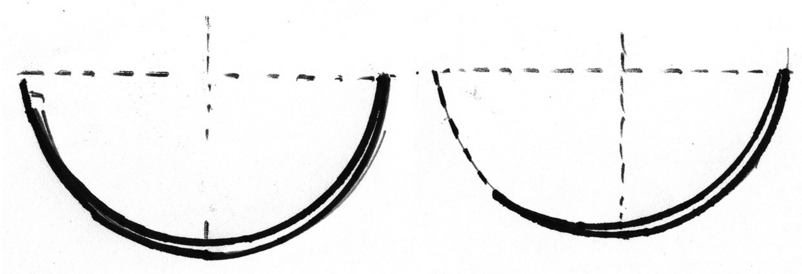

Fig. 1 ½ circle needle (Rt), 3/8 circle needle (Lt)

The point is the part that extends from the tip of the needle till the maximum cross section of the body and it determines how easily sutures pass through the tissue. Cutting and taper point (round) needles (Fig. 2) can be used by the ophthalmic and oculoplastic surgeons.

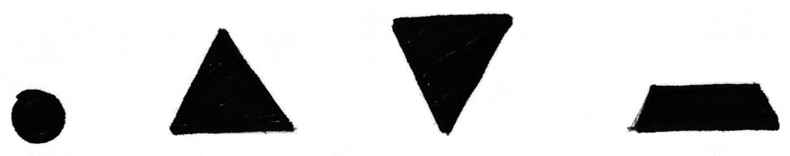

Fig. 2 Cut section of the needle tips. From left to right; taper (round), cutting, reverse cutting, spatulated

Taper point or rounded needles cut only at the tip and pass through tissues by stretching without cutting thus minimizing potential tissue tearing. They are used for easily penetrated tissues and their use is limited in oculoplastic surgery but can be used to close mucosa and for temporary tarsorrhaphy.

The majority of needles used in practice are cutting needles (Fig. 2). They have at least 2 opposing cutting edges and pass through tissues by cutting. Three types are available;

(a) Conventional cutting: They have triangular cross-section that changes to a flattened body. The third cutting edge is on the inner, concave curvature (surface-seeking) and it cuts at the tip and edges. The suture pass is superficial to the needle path. However, this type of needles may pull out tissues during its passage enlarging the needle pass.

(b) Reverse cutting: They are the most commonly used. They also have a triangular cross section yet the third cutting edge is on the outer convex curvature of the needle (depth-seeking) and it also cuts at the edges and tip. The suture pass is beneath the needle path. It has less cutting out of the tissues and is usually used in oculoplastic surgery . Nevertheless, accidental perforation may occur with partial thickness suture such as rectus scleral fixation.

(c) Side cutting/spatulated: Their cross section is flattened and designed to pass in a lamellar fashion as they cut at the tip and the sides parallel to the tissue plane. They provide easy penetration and better control while avoiding accidental perforation. They are designed for ophthalmic procedures but can be used for attaching the levator aponeurosis to the tarsal plate.

The size of the needle corresponds to the suture size and the choice depends on the type of the tissues to be sutured. For example, thick tissues with greater tension require larger sutures and needles .

Stitch craft

Skin sutures can be interrupted or continuous. Interrupted sutures allow precise wound alignment, eversion of the edges and selective suture removal when required. They are preferred in areas outside the skin lines and in irregular wounds. They can be either simple sutures , horizontal or vertical mattress.

The simple interrupted sutures (Fig. 3) are the commonly used. The wound is better divided into halves and each half is further divided into halves and so on so that the sutures are distributed over the wound. The needle should take an equal bite on each side and should include at least the entire thickness of the dermis. To achieve edge eversion, the base of the sutures should be slightly wider than the surface.

Fig. 3 Interrupted sutures

Vertical mattress sutures (Fig. 4) are used when more eversion is needed, e.g. in lid marginal wound repair. The vertical mattress suture is like a U-shaped loop with the outer limits placed deep and inner limits placed more superficial.

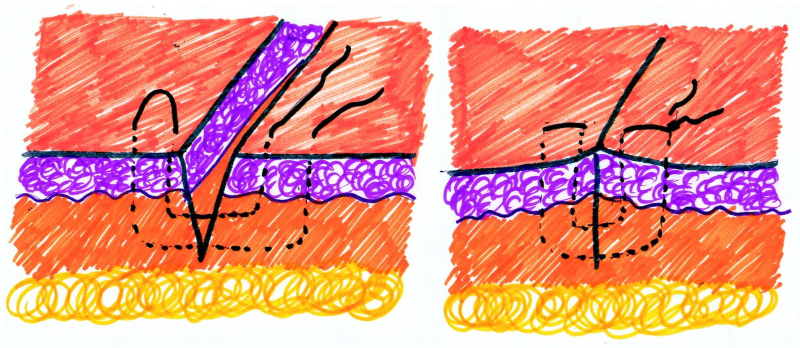

Fig. 4 Vertical mattress suture

Horizontal mattress sutures (Fig. 5) are used for levator muscle attachment to the tarsus during ptosis surgery or if sutures are taken near the lid margin so that the knot is away from the cornea.

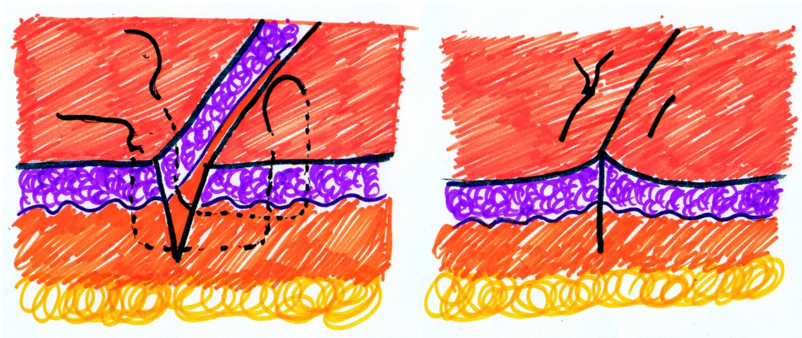

Fig. 5 Horizontal mattress suture

If there is no tension on the wound, interrupted sutures are usually enough. However, if there is tension, the use of buried absorbable sutures or continuous intradermal (subcuticular) sutures is suggested thus allowing early removal of skin sutures without fear of wound disruption.

Deep or buried sutures are also used to close any dead space to prevent hematoma, stabilize the wound and anchor muscle flaps or skin.

Subcuticular sutures can be done using a monofilament suture material to reduce wound tension and minimize leaving suture marks. Although they can be used on their own, it was found that additional interrupted sutures make the wound edge opposition more accurate.

Continuous or running sutures (Fig. 6) whether locked or not are faster to place and easier to remove. They are used to close linear wounds especially those placed in crease lines.

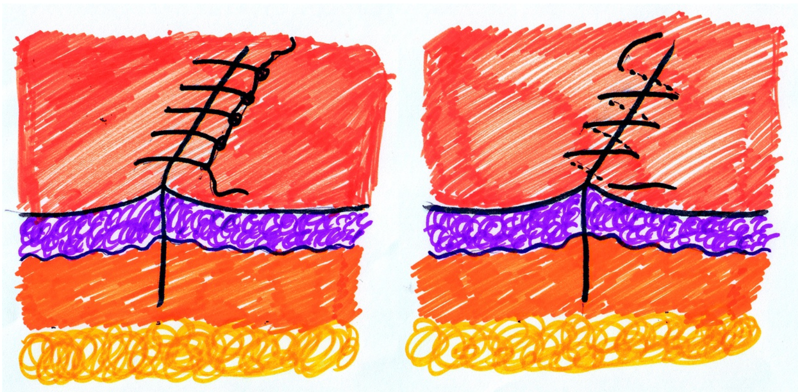

Fig. 6 Continuous locked suture (Left), continuous non locked sutures (Right)

Management of Dog ears

They are usually created by redundant tissue at the end of the incision. They can be due to unequal incision length or incisions that are joined at an acute angle. If not removed, they tend to remain prominent and affect the overall appearance of the scar.

A proper wound design minimizes their occurrence. However, to remove a dog ear, the wound should be sutured till the elevation becomes prominent. The extent of the dog ear is then identified by raising it above the wound level. An incision is then placed at the base of one side finishing at the wound line to create a flap. The flap is then brought across the wound and the excess skin is removed (Fig. 7).

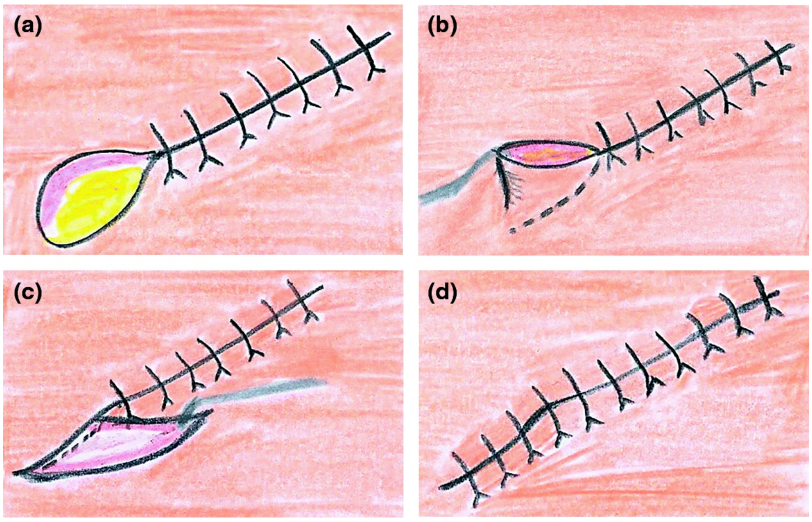

Fig. 7 Removal of dog ear. **a** The wound is closed until the dog ear is apparent. **b** A hook is used to define the dog ear and an incision is made at the base at one side. **c** The excess triangle of skin is removed. **d** The wound is closed at the dog ear area

Basics of flaps and grafts

Skin grafts and flaps are very useful tools in many situations dealing with skin defects such as trauma with tissue loss, after tumor excision, congenital defects and managing scars.

Grafts are usually avoided in conditions with deep spaces as well as exposed bones or cartilage where flaps are preferred.

Basics of grafts

Free skin grafts are either:

- Full thickness graft; that consists of the epidermis and the whole thickness of the dermis and shows less contracture upon healing. It requires a good vascular bed and a longer time to be taken. It is usually harvested using a scalpel and the donor side should be closed. This type is commonly used in the face and neck area and its use is restricted to relatively small defects.
- Split thickness graft; that consists of the epidermis and variable proportion of the dermis. It is usually harvested by a special instrument. It is less vascular with easier take yet more likelihood of contracture. It is not used in the periocular area.

When the graft is applied to its recipient bed, it initially adheres by fibrin that breaks down within 48 hours. This usually coincides with revascularization that encompasses outgrowth of capillary buds from the recipient to unite with those on the deep surface of the graft. This becomes well established by the 3rd day where the graft appears pink in color. Fibroblasts of the bed proliferate and lay collagen to replace the fibrin and the graft is usually anchored to its bed by the 4th day. Lymphatics and nerve supply will be reestablished afterwards.

From the above mentioned, the success of the graft take depends primarily on the extent and speed of vascularization. This is determined by the characteristics of the bed, the character of the graft itself and the conditions under which the graft was applied to its bed.

A well perfused bed is necessary for graft take. The face areas are good recipients and even its fat is highly vascular. Bare bone or cartilage as well as areas exposed to previous irradiation are poor graft beds. The patient's general condition as well as smoking may also affect the bed microcirculation.

A graft harvested from a highly vascular donor area will likely be easier to take which is better for thin grafts compared to thick grafts. The head and neck areas are highly vascular allowing good take of full thickness grafts.

Provided the bed is vascular and free from pathogens, it is of utmost importance that the graft should be in the closest possible contact with its bed (no hematoma or seroma) and immobile.

Harvesting the Graft

Common donor sites for full-thickness skin grafts of the periocular region include the post auricular region, the eyelids, the supraclavicular region and the upper arm. The first two sites provide a good skin matching characters like texture and color, besides, the scar at the donor site is cosmetically accepted.

The free graft should be accurately fitting in its recipient area with normal skin tension. The size and pattern can be determined by a template using cardboard, paper or aluminum foil. The defect should be displayed to the full before making the pattern to avoid post-operative shortage or ectropion . The template is then applied on the donner area and the skin is marked.

On harvesting the graft, it should be cleared from any fat on its deep surface, either primarily during harvesting or after the graft is cut out using scissors. The donor site is then closed primarily.

The recipient bed should be dry before applying the graft so that no hematoma could collect beneath the graft. Excessive cauterization in the bed should be avoided and simple pressure for enough time is preferred. The graft is sutured to its bed margins. Small grafts could be left exposed.

If the applied graft is large, the surgeon should avoid presence of dead space and collection of hematoma beneath the graft. Few stabs in the graft can provide a possible exit for any blood to be collected. A nonadherent dressing is usually applied with gentle pressure (<30 mmHg) before the final dressing. A "Tie-over dressing" is useful, because it minimizes the risk of hematoma or seroma formation without exerting high pressure on the graft and it also prevents shearing forces from outside.

Basics of flaps

A flap is a unit of tissue that is transferred from a donor to recipient area while keeping its own blood supply. Flaps can be classified according to their composition, location or blood supply and there is usually an overlap between these classifications. Flaps range from simple advancements of skin and subcutaneous tissue to composite flaps that may contain any combination of skin, muscle, bone, fat or fascia. Flaps can either be local or distant that use donor tissue from sites not adjacent to the recipient bed. Flaps that have no specific blood supply are known as random flaps while those having a specific vascular supply in the long axis are known as axial flaps.

Local skin flaps

They are the commonest type used in reconstructing the periocular region. The skin is borrowed from areas of relative excess and transposed to close an adjacent defect. The choice of the flap depends on the site and size of the defect, and the availability of the surrounding tissue. The donor site is closed, and the scar is better planned to be in a natural skin line.

Based on their method of movement, local flaps are classified into sliding flaps, advancing flaps and pivotal flaps.

Sliding flaps

This is one of the most helpful techniques to facilitate wound closure. They are simply achieved by generous undermining of the wound margins. The dissection is carried out until the surgeon is able to draw the wound edges together without tension (Fig. 8). Closure under tension may cause wound dehiscence, wide scars with atrophic or hypertrophic appearance.

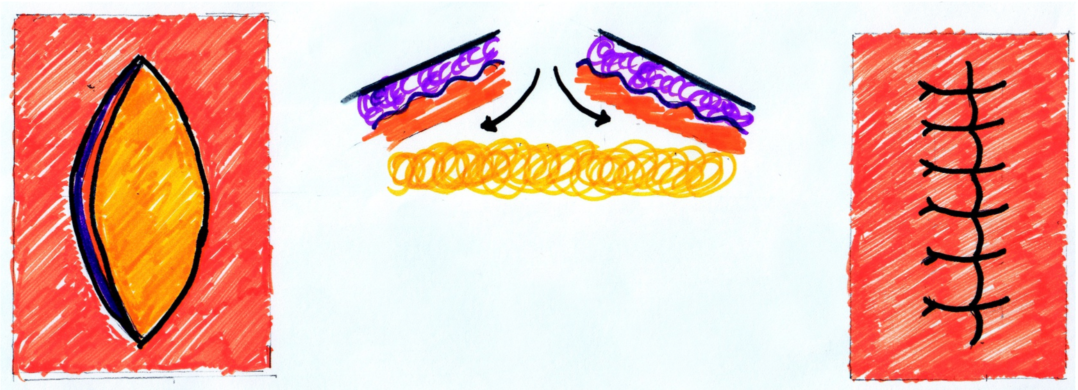

Fig. 8 Closure of an elliptical wound (Lt) using undermining at the edges and sliding the skin to achieve closure without tension

Advancement flaps

They are designed to slide towards an adjacent defect in a single vector without rotation or lateral movement. They are useful in square or rectangular defects.

The flap is usually designed in a way that the length to be 2.5–3 times the width to avoid sloughing. This complication is rare in the lids due to high vascularity.

The flap should be completely dissected until it can be mobilized into the defect with no or minimal tension. An area of stress may appear along the edges of the advancing flap that may hinder its advancement. Excision of small triangles called Burow's triangles at these areas will facilitate the flap movement (Fig. 9).

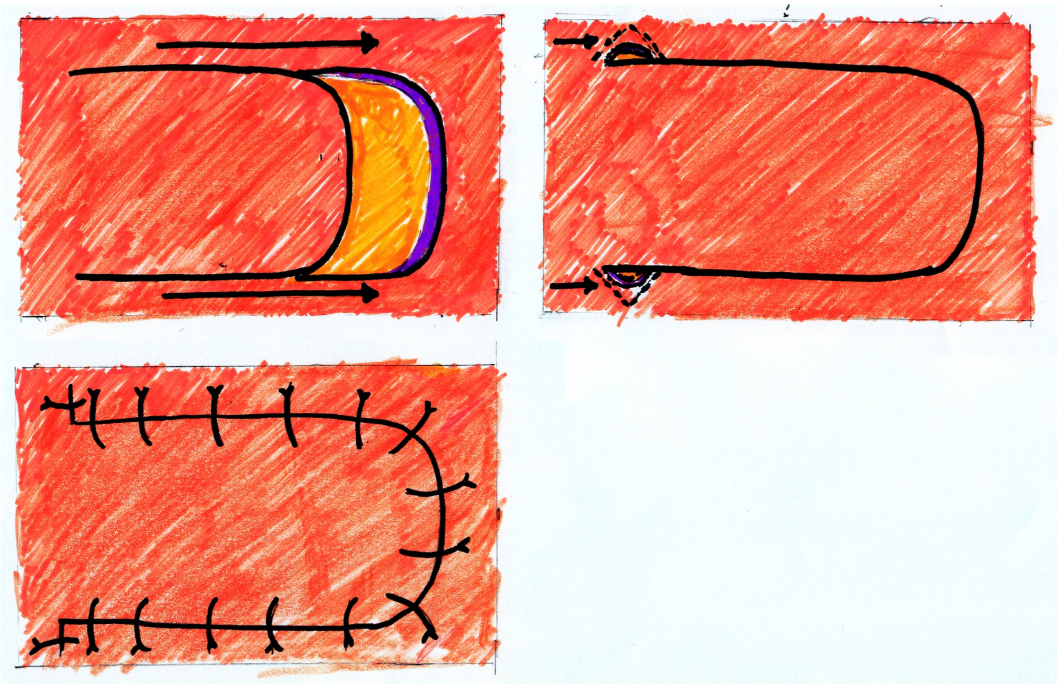

Fig. 9 Unipedicle advancing flap moving towards the defect's direction, small Burrow's triangle (small arrows) are removed at the flap base to

achieve good closure without tension

Bilateral/ bipedicle flap provide more coverage compared to single/unipedicle flap. V–Y and Y–V repairs are also considered advancement flaps.

V–Y plasty (Fig. 10) is widely used in the face and is very helpful in canthus reconstruction. It can be used to close a defect and to release tension. A V shaped incision is placed along its tension meridian while bisecting the V. The flap is then advanced, and the donor site is closed in a Y fashion. Although in this flap, the skin is not dissected from the underlying tissue, the area lateral to the V is undermined to release the flap. Closure of the lower limb of the Y first will further help advancing the flap into the defect. It is possible to turn Y to V in a reverse manner.

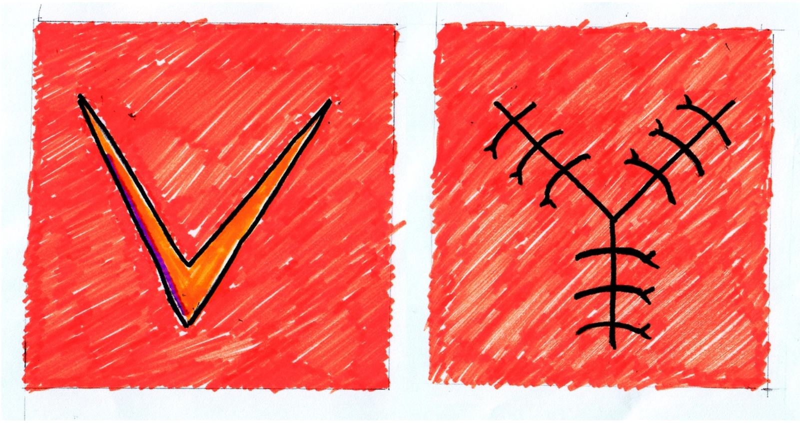

Fig. 10 V–Y plasty

Pivotal flaps

These flaps pivot on a point or a shared base to cover the defect. The greater the pivot, the shorter the effective length of the flap. They include rotational, transposition and interpolation flaps

a. Rotational flaps:

They have a curvilinear or semicircular configuration and they are best used to close a triangular defect. They are designed immediately adjacent to the defect with one border of the flap is the border of the defect (Fig. 11). Ideally, the ratio between the flap length and the width of the defect base should be 4:1 and the ideal defect for repair has a height twice the width in size. Excision of a Burrow's triangle at the base usually facilitate the flap rotation. The greatest tension is present at the recipient site. The donor site is either closed directly or using a skin graft . Tenzel's semicircular flap and cheek rotation flap are examples of such flaps.

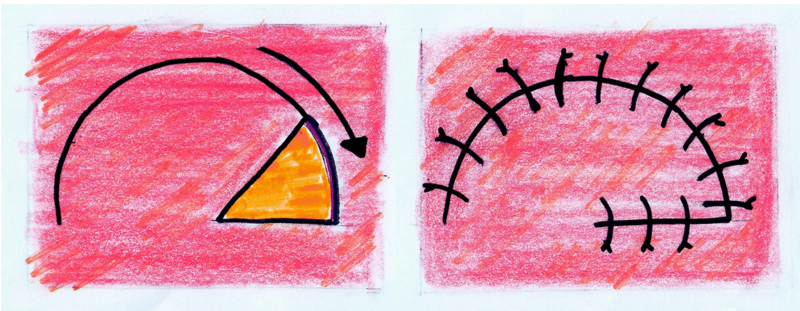

Fig. 11 Closure of a triangular defect using a rotational flap . The greatest tension is at the recipient site

The rhomboid (Limberg) flap:

This is a rotational flap variation that provides minimal tension at wound closure and preserves the natural distances at the site of its use. The tissue to be removed should have a rhomboid shape and the orientation of the excision site is an important key for successfully creating this flap.

The surgeon should identify the direction in which the skin is most extensible. This line becomes the lateral aspect of the flap. In cases of the eyelid reconstruction, perpendicular lines to lid margin should be avoided as they induce excess tension and lid margin malposition. This technique is commonly used in reconstructing the areas lying between the eyebrow and the anterior hairline.

A rhomboid is designed with its short diagonal equals the length of each side and the angles are 120° and 60° as shown in (Fig. 12). The short diagonal is then extended for a distance equal to its length, bisecting the 120° angle. A lateral incision is placed at the end of the extended diagonal at 60° angle, parallel to the top or bottom sides according to the direction in which the flap will be rotated and of the same length as the rhomboid side. The flap is dissected from its site and rotated into the defect, then sutures are taken to secure it in place (Figs. 12 and 13a–c).

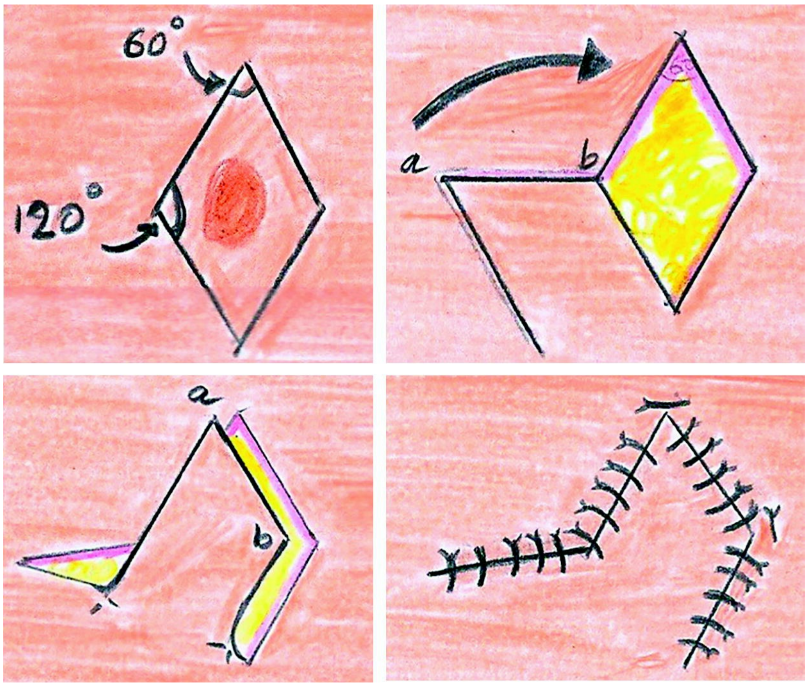

Fig. 12 Creation of the rhomboid flap: tissue excision, design, rotation and closure of rhomboid flap

Fig. 13 **a** Basal cell carcinoma affecting the temporal region lateral to orbit. **b** Design of excision with safety margin and a rhomboid flap. **c** Excision of the lesion and closure of the defect

b. Transposition flaps:

They have a linear configuration that is laterally rotated about a pivot point into an immediately adjacent defect. The flap shares the base with defect site with the greatest tension is at the donor's site (Fig. 14). The flap must be designed to be longer than the defect as the effective length of the flap becomes shorter the farther the flap is rotated. A cut back incision may be of help. Transposition skin flap from the upper to the lower lid is an example.

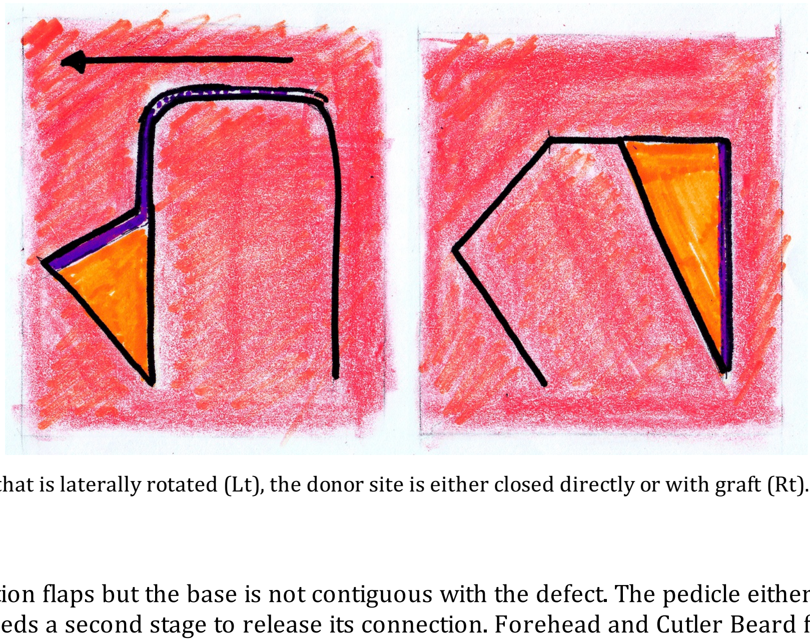

Fig. 14 A transpositional flap that is laterally rotated (Lt), the donor site is either closed directly or with graft (Rt). The greatest tension is at the donor's site

c. Interpolated flaps:

They are like transposition flaps but the base is not contiguous with the defect. The pedicle either crosses over or under an intervening tissue and it needs a second stage to release its connection. Forehead and Cutler Beard flaps are examples of this type.

Z-plasty:

Z-plasty is an important surgical technique in revising a scar or releasing a scar contraction as it elongates the tissues and changes the scar axis with a more cosmetic appearance.

It is a transpositional flap in which two triangular flaps are reversed and rotated 90°. The central limb is placed along the scar to be excised and the three limbs of the Z must be of equal length to facilitate closure. The lateral limb to central limb angles should be equivalent and the gained length is related to this angle. The 60° Z-plasty is most effective because it lengthens the central limb without placing too much tension laterally (Fig. 15).

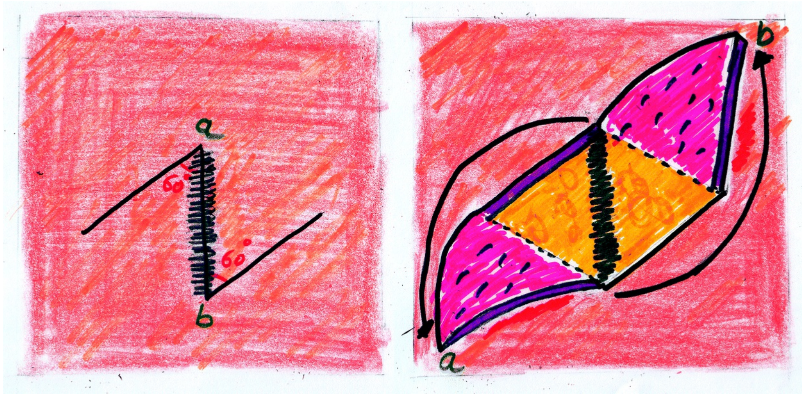

Fig. 15 Creating the flaps by placing the central limb along the scar line, the two other limbs are of equal length at 60°. The arrows show the direction of **a** and **b** upon flap creation

In designing the Z-plasty, the surgeon should consider that the final position of the scar will be perpendicular to the original central limb, hence it should be planned to be parallel to the skin lines. Consecutive Z-plasties can obliterate skin straight line scars yet result in transverse shortening and lateral tension on the wound.

After the flaps are created, it is essential to release and excise the subcutaneous bands to make the flaps freely mobile. They are then transposed, and their bases anchored first (Fig. 16). The tension along the flap is evenly distributed using interrupted sutures . Inequality of flaps may cause stress on the wound with poor outcome. If making flaps with equal angles is not feasible, the difference between them should not exceed 20°.

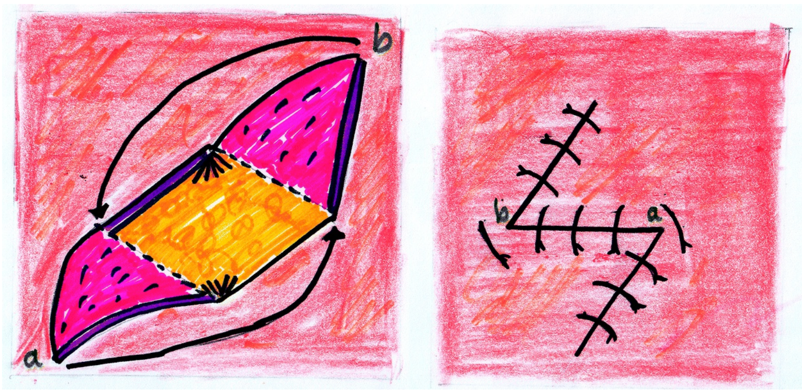

Fig. 16 The subcutaneous scar is removed. The arrows show the direction of flap movement. The flaps are then closed

Forehead Flap

Tissues from the forehead could be elevated to replace lower or upper eye lid defects. To minimize unsightly scar at the donor area the flap is raised either above the eye brow or just in front of scalp hair line. The incision at the site of hair line is slanted away to avoid injuring hair follicles with possible resulting alopecia. If a long flap is needed it could be delayed as a bipedicle flap for two week before harvesting.

After insetting the flap the inner surface is covered by mucous membrane graft and in the lower eye lid a cartilage support may be needed at a later stage (Fig. 17a, b).

Fig. 17 **a** Upper eye lid defect in a case of subtotal excentation. **b** Reconstruction of the upper eye lid with a forehead flap

Mustarde Flap

This flap is very useful for a major defect of the lower eye lid. It is a major facial flap in which the whole cheek is mobilized. The incision starts at the lateral end of the defect and goes at a higher level than the outer canthus until it reaches the front of the auricle then is directed downwards in front of auricle like a face lift incision. The whole flap is mobilized at the subcutaneous level and moved medially at its upper end to reconstruct the lower eye lid. The donor site is usually closed primarily and very easily especially in the older age group (Fig. 18a, b).

Fig. 18 **a** Basal cell carcinoma affecting most of the lower lid. **b** Excision of the lesion with safety margin and reconstructing the lower lid with Mustarde flap

Inner Canthal Defects

Inner canthal defects present a challenge especially when deep as it is usually associated with disturbance of the canalicular anatomy. In addition repair of the medial canthal tendon or applying a tendon graft that is sutured to the posterior lacrimal crest should be done.

The skin defect itself is usually covered by a skin graft (Fig. 19a–c). An alternative is a transposition flap from nose, glabella or forehead, but the main disadvantage of these flaps is its bulkiness which may need thinning in a second stage (Fig. 20a, b).

Fig. 19 **a** Basal cell carcinoma at inner canthus. **b** Excision with safety margin. **c** Closure of the defect with split thickness skin graft

Fig. 20 **a** Basal cell carcinoma affecting inner canthus. **b** Excision and closure of the defect with a glabellar flap with noticeable bulkiness

Some authors suggest leaving medial canthal defects to granulate and heal by secondary intention. This takes long healing time and can lead to ectropion of the medial aspect of the lower lid. This method may be useful only for small defects.

Eye Brow Injuries and Defects

Wounds of the eye brow should be meticulously sutured with proper alignment of the upper and lower border of the brows. If the wound is deep it should be closed in layers to minimize scar stretching. However in spite of the best efforts many wounds of the eye brow will show few weeks after healing as a hairless scar. This could be managed by scar revision and follicular hair transplantation from the opposite or the same brow.

In many occasions brow injury is associated with injury to upper eye lid and forehead. It is advisable to correct the brow first and guarantee its proper alignment then consider forehead and lid injury and if there is a forehead skin defect it should be managed without compromising. The brow alignment is by using properly designed flaps or skin grafts . Deformities of the brow resulting from closing forehead defects without respect to brow alignment are more difficult to correct at a second stage.

If the brow is obviously shorter than the opposite brow follicular hair transplant from opposite brow can correct the shortening. In females tattooing can camouflage this starting.

In large or total brow loss a superficial temporal island flap from scalp could be harvested to reconstruct the brow but the hair is usually denser than the normal brow and needs to be regularly cut or shortened. Tattooing especially in females is an alternative.

Complications of Flap Reconstruction

Variable complications following flaps reconstruction may occur, yet most of them are preventable and can be treated.

Early complications include infection, hematoma, seroma, and wound dehiscence. Flap necrosis is a serious complication and can be due to improper design or execution. It can be avoided by precise flap design and avoiding violation of the flap blood supply as well as closure under tension. If distal necrosis occurs, treatment is conservative and the area could be left to heal by secondary intention or subsequent surgical revision based on the situation.

Late complications such as unfavorable scars that can be avoided by proper planning. When they are mature, they can be revised or corrected using Z-plasty.

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Anaesthesia in Oculoplasty

Oya Yalcin Cok[1] ✉ and Ezzat Sami Aziz[2]
(1) Department of Anaesthesiology and Reanimation, School of Medicine, Adana Research and Education Center, Baskent University, 01250 Adana, Turkey
(2) Department of Anaesthesiology, Cairo University, Giza, Egypt

✉ **Oya Yalcin Cok**
Email: oyacok@yahoo.com

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Introduction

Anaesthesia is an indispensable component of every surgery. However, every surgical specialty and subspecialty has its own needs and requirements regarding anaesthesia management. The oculoplastic procedures also need tailored approaches of local, regional and general anaesthesia techniques. This chapter will cover the main anaesthetica techniques used during oculoplastic surgeries, related anaesthetic drugs and some practical advices for anaesthesia management.

Local Anaesthesia

Local anaesthesia techniques sufficiently cover the requirements of most of the oculoplastic surgeries. These techniques include topical anaesthesia with local anaesthetics (LAs) and intradermal or subcutaneous LA administration as infiltrations. They can be used both alone and in combination with each other.

Topical Anaesthesia

Topical anaesthesia, mostly reserved for ocular surgeries, still can be used for brief and superficial procedures of the globe, conjunctiva, and the lids or prior to infiltration anaesthesia to ease the injection pain. It has an advantage of less distortion of the surgical site. Especially, cornea and conjunctiva are very susceptible to topical local anaesthetic effect in where nerve endings are very superficial under a tear film and a thin epithelium. The local anaesthetics for topical anaesthesia are used in the form of eye drops, gels, creams, ointments, sprays and patches. Furthermore, local anaesthetic soaked cotton tip applicators may be used for topical anaesthesia of the conjunctiva. These drugs have higher concentrations of local anaesthetics and may be readily absorbed to the systemic circulation in high amounts.

Local Infiltration Anaesthesia

Local anaesthetic infiltration is an easy technique to provide a pain-free surgical area for many of the oculoplastic procedures. It is also suitable in some selected paediatric cases. In this technique, local anaesthetics (LAs) are injected into the soft tissue of the operative site. It may be accompanied with or without sedation.

Some technical issues should always be considered during local anaesthesia as follows. Local infiltration should always be utilized after cleaning the skin with appropriate material. The needle used should be sufficiently long to avoid multiple insertions, by long passes beneath the skin. This may help decrease the severity of pain and bruising. The syringe should be tightly secured to the needle with the bevel up; a Luer-Lok syringe should be used if possible to prevent needle expulsion which may cause inadvertent penetration of the globe or surrounding tissue. Eyelids are thin structures and they are not resistant to inadvertent full-thickness penetration. Penetration to the globe or corneal puncture should be suspected if the ballooning following LA infiltration ceases immediately.

Concerns During the Local Infiltration Anaesthesia for Oculoplastic Surgery

The local anaesthetic injection causes mild to moderate pain, burning, stinging sensation due to the needle insertion and acidity of LAs. Local anaesthetic injection rate affects injection pain in oculoplastic procedures as slower injection enables less painful infiltration. A smaller gauge needle may also alleviate the pain of injection. Because overall pain sensation and satisfaction during the surgery highly correlates with the initial pain during local anaesthetic infiltration, this is an important matter, especially at the office setting where a higher patient satisfaction and perception of good care are desired. Needle-free jet injections are not recommended for oculoplastic procedures. However, there are still ongoing and promising studies for new needleless alternatives such as nano enabled (nanoparticle) local anaesthetic delivery systems for oculoplastic surgery.

Periocular anaesthetic injections may trigger a forceful reflex sneezing (sternutatory reflex), even under sedation. This possibility should be anticipated and the needle should be drawn quickly to prevent deeper penetration.

A technical concern about local anaesthetic infiltration is its potential to distort the original anatomy of the patient that may be especially important in correction surgeries. This may be due to mass effect or haematoma formation. Therefore meticulous planning of the surgery should be made and drawn on the skin prior to local anaesthetic administration. Especially during ptosis surgery, the use of epinephrine may also result in upper eyelid retraction due to sympathetic activation of Müller muscle. On the other hand, LA diffusion to levator muscle may cause paralysis and make height adjustments difficult. This can be avoided by limiting the LA volume to less than 1 mL in the upper lid.

There are some complications that can be encountered due to periocular injections. First of all it is wise to check if the patient is on anticoagulant drugs and to cease them under the control of prescribing physician to avoid bleeding-related complications such as retrobulbar haematoma. Allergic reactions to LAs are rare, but, they may be observed against the preservatives or the antioxidants in the formula of the local anaesthetics. Systemic local anaesthetic toxicity is less expected since the use of large volumes and high concentrations of local anaesthetics during oculoplastic surgery isn't expected. But it may be of concern during tumescent anaesthesia or with large infiltration areas during full facial reconstruction. The initial symptoms of local anaesthetic systemic toxicity include central nervous system symptoms and signs such as anxiety, dizziness, tinnitus, restlessness, and tremor, and, sometimes, convulsions. Respiratory and cardiac alterations may co-exist or follow central nervous system disturbances. The management includes supportive therapy such as prevention of hypoxia, cardiopulmonary resuscitation and lipid emulsion therapy.

Blocks

The blocks used for oculoplastic surgery includes ocular blocks such as retrobulbar, peribulbar and sub-Tenon blocks and periorbital blocks of separate nerves. They can be used alone or in combination with each other to cover the surgery site. They cause minimal discomfort, lower cost, and lower perioperative morbidity in comparison to general anaesthesia. They also provide the advantages of less local anaesthetic use and minimal tissue distortion when compared with infiltration anaesthesia. These blocks may be utilized with a blind technique or with the use of ultrasound guidance.

Ocular Blocks

Ocular blocks include retrobulbar, peribulbar and sub-Tenon blocks. They provide the anaesthesia of the globe. The local anaesthetic is injected into intraconal space, extraconal space by a needle and into sub-Tenon's space by a cannula during retrobulbar, peribulbar and sub-Tenon blocks respectively. However, they have very limited use for oculoplastic surgery. They have been reported to have beneficial effects such as longer optic nerve transection, less pain, less postoperative nausea and vomiting following eye amputation procedures.

Periorbital Nerve Blocks

Periorbital sensorial nerve blocks include supraorbital, supratrochlear, infratrochlear, zygomaticotemporal, zygomaticofacial, infraorbital, maxillary nerve blocks. The facial nerve must be blocked for motor blockade of the relevant muscles in the area. Here, the blocks will be described starting from the peripheral and the superficial to the main branches and the deeper ones.

Supraorbital Nerve and Supratrochlear Nerve Blocks

The supraorbital nerve and the supratrochlear nerve are two of the terminal branches of the frontal nerve which is the largest branch of ophthalmic division (V1) of the trigeminal nerve. Both nerves exit the orbit anteriorly and superiorly. The supratrochlear nerve and the supraorbital nerve are located approximately 1 cm and 2 cm lateral from the midline of the forehead on the supraorbital ridge, respectively (Fig. 1). The supraorbital nerve exits from the supraorbital notch or foramen at 0.5–0.7 cm above the supraorbital margin which are usually palpable and visible under ultrasound guidance.

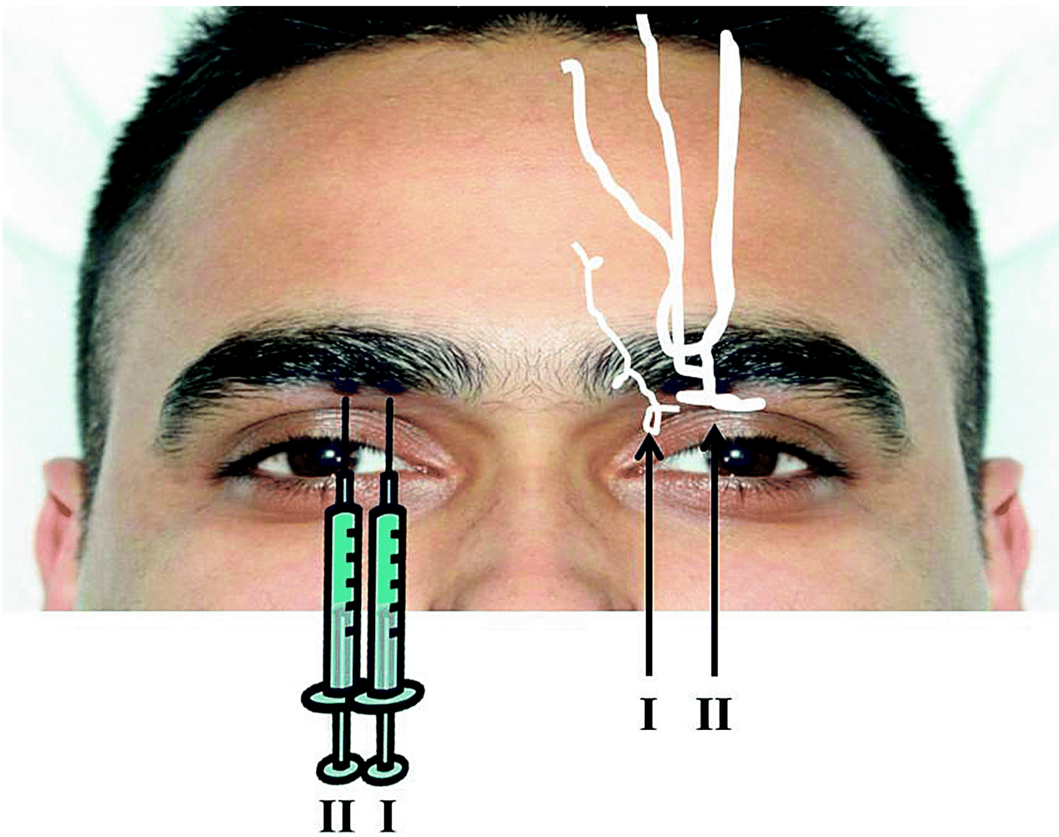

Fig. 1 The supratrochlear and the supraorbital nerves and the respective block sites. I: The supratrochlear nerve, II: The supraorbital nerve

The blockade of supratrochlear and supraorbital nerves provides anaesthesia for procedures such as repair of lacerations, debridement, removal of foreign bodies, oncologic interventions of the forehead and upper eyelid without compromising levator function and specific neuralgias of the related nerves.

The supraorbital nerve can be blocked by a 23–30 G needle inserted perpendicular to the skin by palpating the foramen or the notch by a blind technique and 1–2 mL of LA should be injected. Direct injection the foramen should be avoided to prevent the nerve injury. The supratrochlear nerve can be blocked at 1 cm medial to supraorbital notch/foramen on the upper orbital margin. A practical technique to block both nerves at once is to infiltrate the medial two-thirds of the eyebrow with one long pass of a sufficiently lengthy needle beneath the eyebrow and inject 4–5 mL LA along while withdrawing the injector.

A high-frequency ultrasound transducer transversely placed on the eyebrow should be moved slowly from lateral to medial while dynamically searching for a break in the hyperechoic edge of the bone indicating the supraorbital notch or foramen (Fig. 2). The foramen or the notch should be checked by colour or Doppler mode to visualise vascular structures. The supraorbital nerve can't be visualised in long axis by this approach, however in-plane needle advancement, sectional view of supraorbital nerve, LA spread around the foramina can be observed during the block (Fig. 3). The supratrochlear nerve may also be visualized medial to the supraorbital nerve on the supraorbital ridge with the use of a high-frequency ultrasound transducer (Fig. 4).

Fig. 2 A high-frequency ultrasound transducer transversely placed on the eyebrow for supraorbital nerve block

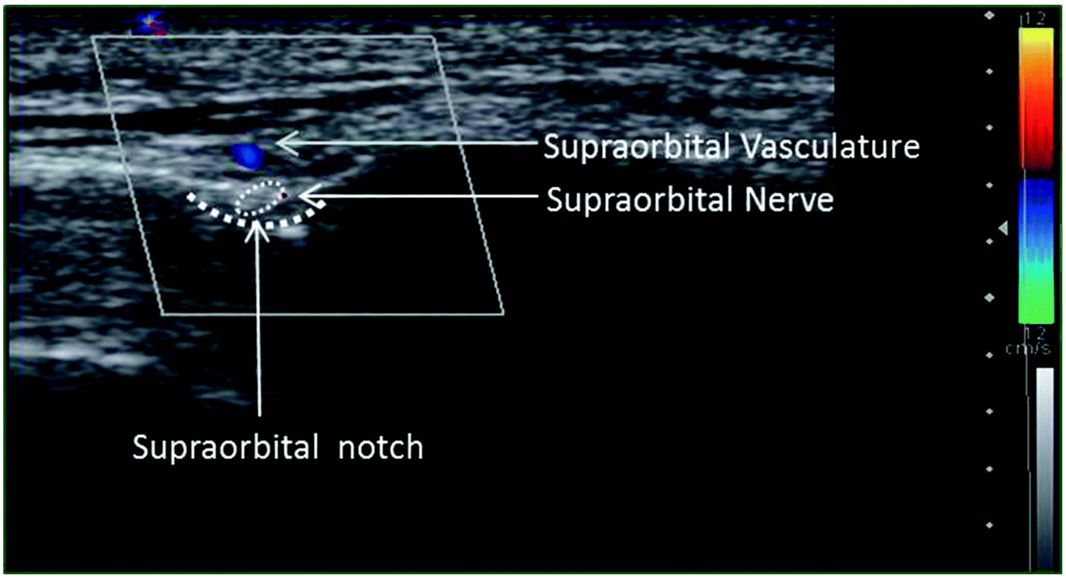

Fig. 3 Ultrasound image for supraorbital nerve block

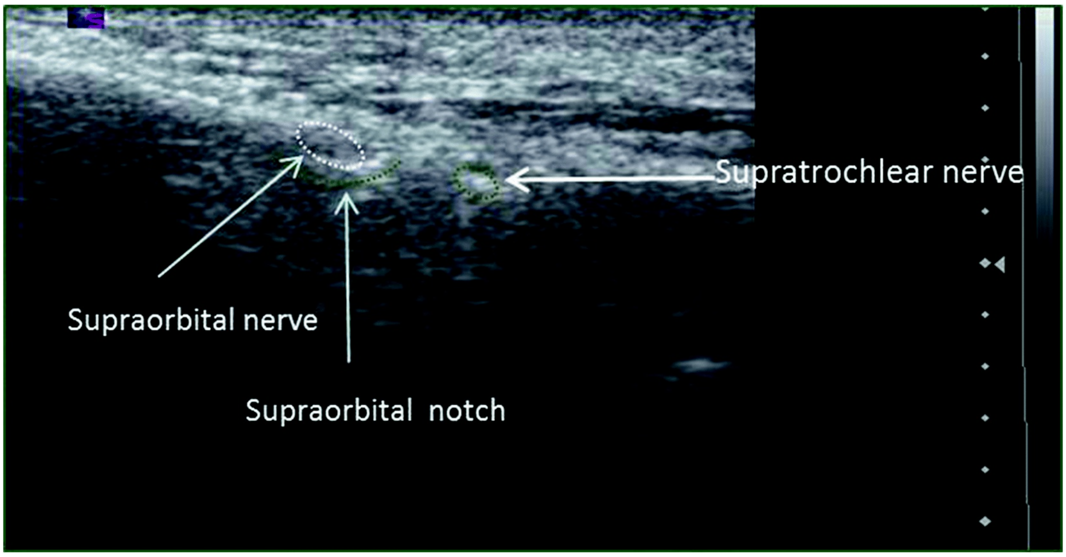

Fig. 4 Ultrasound image for supratrochlear nerve block

Infratrochlear Nerve Block

The infratrochlear nerve is one of the terminal branches of the nasociliary nerve, which is a branch of the ophthalmic division (V1) of the trigeminal nerve. It travels along the medial wall of the orbit before leaving over the medial canthus. The branches of the infratrochlear nerve are distributed throughout the medial area of the upper eyelid and 1/5 of the medial part of eyebrow height. This nerve innervates the internal angle of the orbit and the medial upper eyelid, the upper bridge of the nose and/or the lacrimal caruncle.

The infratrochlear block is performed by administering 0.5–1 mL of LA with the needle inserted 0.5–1 cm above the medial canthus at the intersection of the nasal base and the orbit (Fig. 5). The blockade of the supraorbital, the supratrochlear and the infratrochlear nerves all at once is possible by 2–3 mL LA injection starting from the midline of the eyebrow to the glabella, however, this technique is more painful than separate blocks of these nerves.

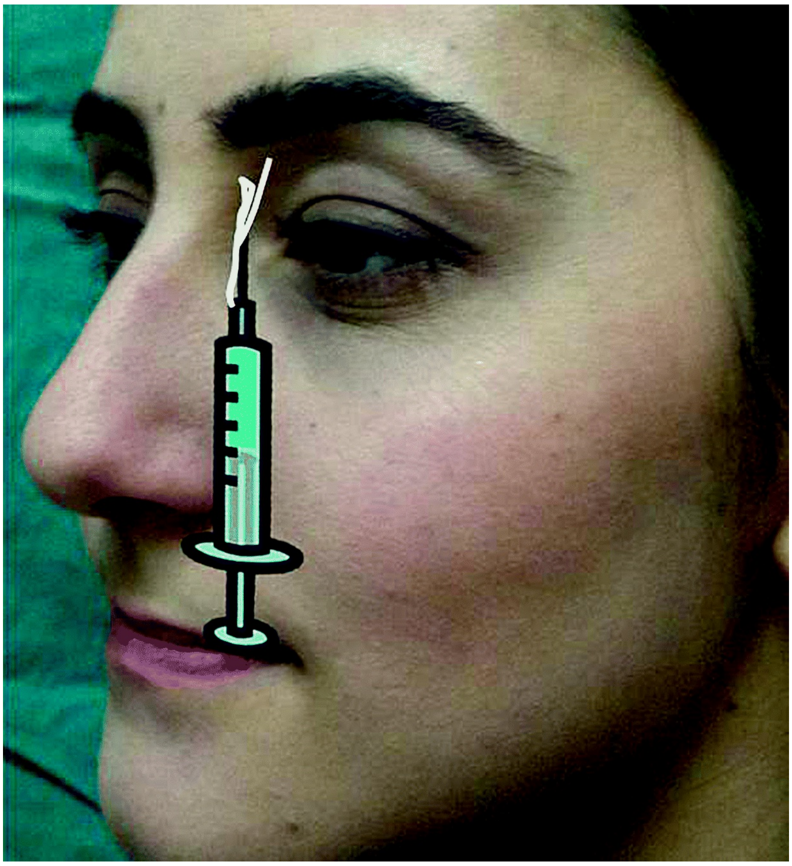

Fig. 5 Infratrochlear nerve and the block site

Zygomaticotemporal Nerve and Zygomaticofacial Nerve Blocks

The zygomaticotemporal nerve and the zygomaticofacial nerve are the peripheral branches of the maxillary division of the trigeminal nerve. The zygomaticotemporal nerve ran along the lateral wall of the orbit and reaches to the temporal fossa between the deep layer and the superficial layer of the deep temporal fascia after passing through the zygomaticotemporal foramen. It has communicating anastomoses with the temporal branch of the facial nerve, which is assumed to be myelinated fibers of proprioceptive or motor function. The zygomaticotemporal nerve innervates an area which is 3 cm lateral to lateral canthus and of 3 cm diameter in adult patients. The zygomaticofacial nerve passes through the lateral wall of the orbit anterolaterally and traverses the zygomaticofacial foramen and it innervates the skin over the zygomatic bone, the inferior region of the temple and the lateral aspect of the lower eyelid.

The blockade of these nerves is indicated when the surgery involves the lateral part of the orbit, separation of temporal muscle from the cranium, lateral part of the lower eyelid, lateral region on the zygoma.

To block the zygomaticotemporal nerve blindly, one should palpate the lateral edge of the orbit at the level of lateral canthus and follow the edge until the superior of the lateral orbital wall at the level of the frontozygomatic suture. The nerve can be blocked at this area (Fig. 6). However, the frontozygomatic suture cannot be palpated in every patient. In this case, the lateral orbital edge must be palpated 1 cm superiorly and then the palpating finger should be moved to into a groove 0.5–1 cm posteriorly. The zygomaticofacial nerve can be blocked at this area which is 1–1.5 cm posterior to frontozygomatic suture and 2 cm superior to zygomatic arch. Due to numerous variations of the zygomaticotemporal nerve location, the block must be performed by superficial and deep injections of 5 mL LA to block both the temporalis and temporoparietalis muscles.

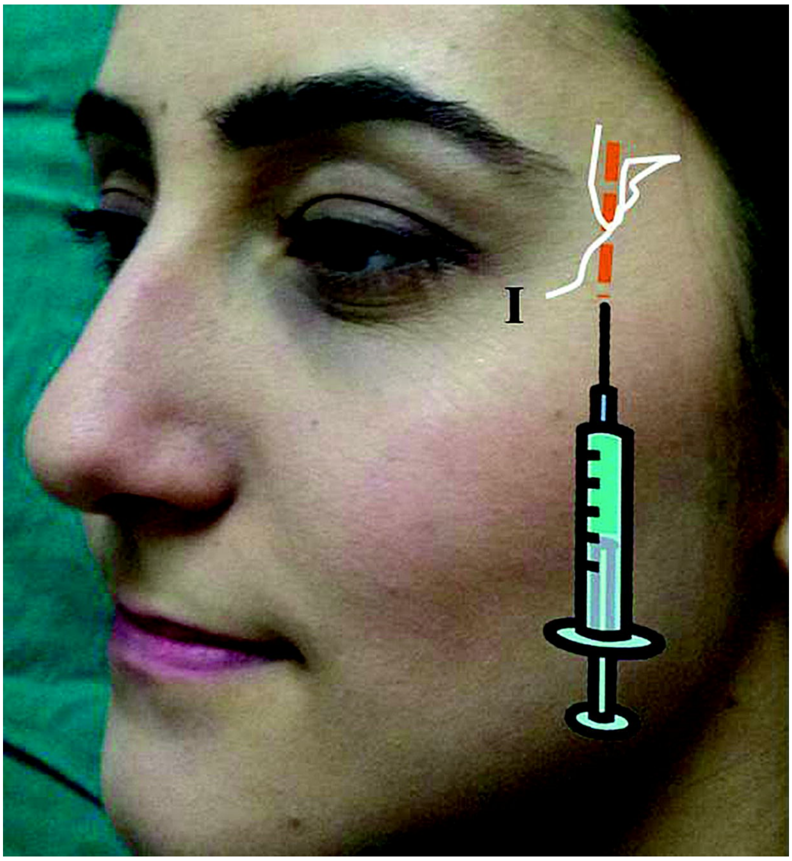

Fig. 6 The zygomaticotemporal nerve and the block site. I: The zygomaticotemporal nerve

The zygomaticofacial nerve can be blocked blindly by subcutaneous injection of 1–2 mL LA to the area 2 cm lateral and 2 cm inferior to the lateral canthus in the proximity of the zygomaticofacial foramen. It may be also blocked by injecting LA at the lateral edge of the orbit at the level of the frontozygomatic suture in the direction of zygoma. It is frequently blocked together with the zygomaticotemporal nerve. The finer the needle used, the less haematoma or bruising at this delicate area. The use of ultrasound guidance for identifying bony and vascular landmarks eases the block of these nerves, especially in obese patients (Fig. 7).

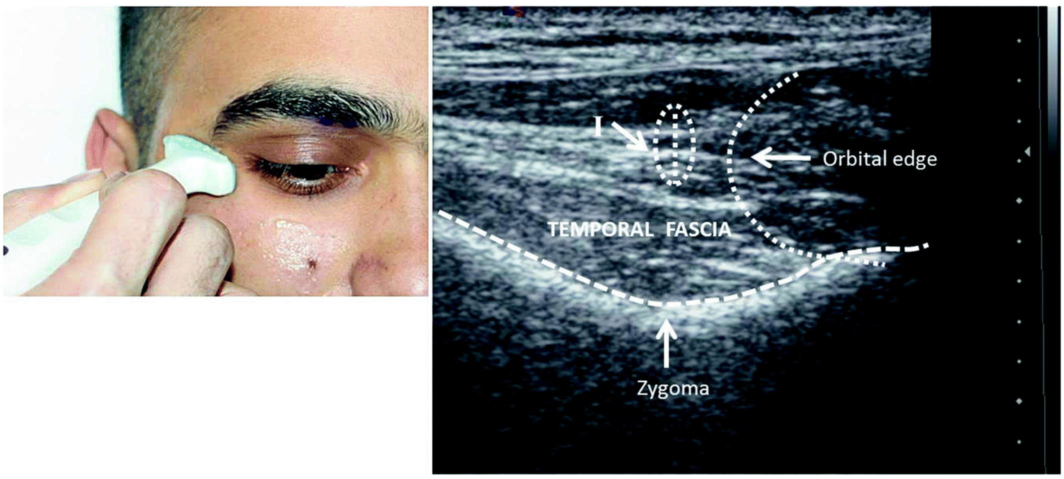

Fig. 7 Ultrasound image for zygomaticotemporal nerve block. I: The zygomaticotemporal nerve block LA injection site

Infraorbital Nerve Block

Infraorbital nerve is a terminal branch of the maxillary division (V2) of the trigeminal nerve. An infraorbital nerve block is indicated for lower eyelid, lateral side of the nose and upper lip anaesthesia.

This nerve is blocked at the site where it emerges from infraorbital nerve. Infraorbital foramen is located at 2 cm below the midline of orbit. Practically, it is on the same virtual line drawn from supraorbital notch and pupil at neutral gaze. This block can be performed percutaneous extra-oral or intraoral approaches and blindly or by ultrasound guidance. During the ***percutaneous extraoral approach***, the infraorbital foramen is palpated according to anatomical landmarks such as the infraorbital ridge and the 1–2 mL LA is deposited subcutaneously by a needle perpendicular the skin (Fig. 8). A deeper injection beneath the muscle is recommended in patients with prominent quadratus labii superioris muscle. The needle should not be introduced into the infraorbital foramen since this may cause globe injury and nerve damage due to direct needle contact, toxicity or local pressure of LA.

Fig. 8 Infraorbital nerve block site with percutaneous extraoral approach

During the ***intraoral approach***, the needle is aligned between the roots of the first and the second maxillary premolar teeth and introduced towards the ipsilateral pupil. Palpating the foramen simultaneously provides control of the LA injection and spread. LA spread can be facilitated by 10–15 second massage after LA injection. Theoretically, blind intraoral approach increases the risk of orbital penetration and globe perforation since the needle trajectory, infraorbital foramen and the canal lies on the same plane. If the needle enters the orbit, a swelling in the lower lid is observed during LA injection.

Infraorbital foramen's location rapidly moves to the more inferotemporal site during the first 3 years and between 10 and 12 years of life and this is finalized around the age of twenty. It is more inferotemporal in male patients in comparison to female patients. In paediatric patients, its distance from the midline can be calculated according to the formula as follows: Distance = 21 mm + 0.5 × age (years).

A high-frequency ultrasound transducer should be placed at the inferior orbital rim and transverse sono-scan is performed until a hypoechoic break in the bone indicating the infraorbital foramen is observed (Fig. 9). The foramen should be checked by colour or Doppler mode to visualise vascular structures. The needle is introduced with the in-plane approach and the block is performed while observing the spread of local anaesthetic at the opening of the foramen. However, sagittal scanning parallel to the nose may also be performed and the same imaging principles apply since the foramen can be found in the same way. In-plane needle advancement and LA spread around the foramina can be observed during the block.

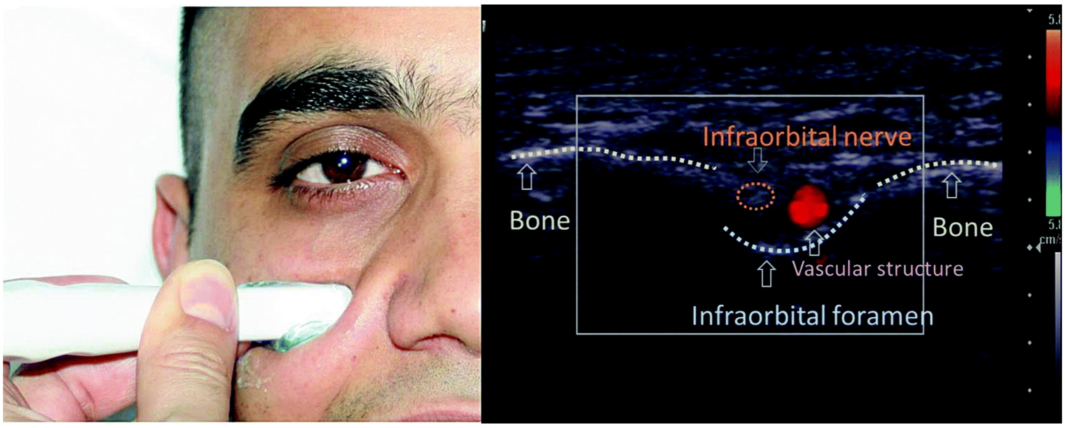

Fig. 9 Ultrasound image for infraorbital nerve block

Maxillary Nerve Block

Maxillary nerve (V2) is one of the three divisions of the trigeminal nerve. The maxillary nerve exits the cranium through the foramen rotundum and enters the pterygopalatine fossa. Then it starts to give its peripheral branches such as zygomatic nerve (the main branch giving off zygomaticotemporal and zygomaticofacial nerves) and infraorbital nerves which innervate the inferior and lateral periocular region. The blockade of this nerve in the pterygopalatine fossa enables to anaesthetise the area innervated by all terminal branches of this nerve at once.

After defining the midline of the zygomatic process, the sulcus beneath the bone should be marked to block the maxillary nerve blindly. A 22G needle should be inserted perpendicularly at this point until it touches the lateral pterygoid plate at around 4 cm depth. Then the needle is retracted and directed upwards for 4.5 cm (not more than 4.5 cm) and 3–4 mL LA is sufficient for the nerve blockade.

During the ultrasound-guided maxillary nerve block, the transducer is placed distal and parallel to the zygomatic arch to bridge the coronoid and condylar processes. The aim of the imaging is to visualize the lateral pterygoid plate and the sphenoid palatine artery, which is a branch of the maxillary artery, flowing to the pterygoid palatine fossa. The needle is introduced to the area anterior to the lateral pterygoid plate which is the pterygopalatine fossa and LA is injected. This block may also be performed with several different approaches.

Facial Nerve Block

The facial nerve block provides motor blockade of the muscles of the face. It doesn't offer sensorial anaesthesia around the eye although it has some communicating branches with the peripheral branches of the trigeminal nerve. Akinesia of the muscles around the eye may benefit some particular surgeries. However, current improvements in oculoplastic techniques minimized the need for this block. The proximal and distal approaches of the facial nerve are Nadbath-Rehman, O'Brien, Atkinson, van Lint techniques and their modifications. In the proximal site, the facial nerve can be blocked by delivering 3 mL LA 1.5 cm deep into the area where facial nerve emerges from stylomastoid foramen, between anterosuperior part of the mastoid and the ramus of the mandible. In the original O'Brien technique, LA is injected directly beneath the condyloid process at the level of the neck of the mandible just anterior to the tragus of the ear. In the modified O'Brien technique, the injection site is at more posterior and inferior of the original approach and approximately 5 mL of LA is injected at the dorsal rim of the mandible near the tragus of the ear at a maximal depth of 1 7 cm. The Atkinson block is performed by subcutaneous injection of 2–5 mL LA at the midpoint of a line between the lower edge of the zygoma and the jaw joint. The modified van Lint block is the most distal of the facial nerve blocks particularly reserved for eye surgeries and practically, 2–5 mL LA is injected below the orbicularis oculi muscle. The more distal the block site gets, the less akinesia is provided. Nadbath-Rehman technique has a higher risk of complications due to its proximity to vagus and glossopharyngeal nerves and these complications include dysphagia, respiratory distress and pulmonary oedema. Van Lint approach causes swelling and distortion of the lids and ocular adnexa and O'Brien technique produces postoperative pain at the site of anaesthesia.

Contraindications of the Periocular Blocks

Infection at the block site, congenital or acquired coagulopathies and the refusal of the patient are a contraindication to block performance. Bone defect or tumours may change the normal anatomy of the block site and may cause an increased risk of complications as well as block failure.

Complications of the Periocular Blocks

Pain during the block performance, bruising and local infection are the common complications during the periocular blocks. Vascular structures accompanying the nerves and the dense vasculature on the face increase the risk of the subcutaneous bleeding. Haematoma formation may be observed in patients who are on anticoagulant and some herbal drugs. However, adding epinephrine to LA is not a recommended practice in these blocks. Pressure due to LAs or direct needle contact may cause nerve injury since most of the nerves of the region are located in a narrow foramen or notch or very superficially. Inadvertent injury to the surrounding structures via the foramina has also been reported, especially during the infraorbital nerve block.

Essential Knowledge for Ultrasound Guidance During Periorbital Nerve Blocks

Ultrasound guidance helps visualizing the supraorbital foramen or notch and vasculature near the block site and efficient spread of LA to minimize the LA volume used. Since periorbital nerves are very superficial and thin structures to visualize, high frequency linear or hockey stick transducer use (>13 MHz) is advocated for these nerve blocks. Higher frequency ultrasound transducers allow better differentiation of the structures at the depth of 0–3 cm. Use of colour or Doppler mode may help distinguish vasculature, especially arteries which are rarely compressible. It is practical to search for the anatomical landmarks such as foramina, notches, and vascular structures during the ultrasonographic scan. Bony structures present as hyperechoic (bright) lines with an anechoic (dark) shadow beneath. A gap in the hyperechoic line may indicate a notch or foramen. Block performance during real-time visualization should be done very cautiously since the distance to be advanced by the needle is very short or superficial for periorbital nerve blocks. Furthermore, needle tip location and the spread of the LA should be observed during the block to prevent direct nerve injury by the needle or the LA volume itself. The sterile technique should be preserved throughout the ultrasound-guided block performance.

Local Anaesthetic Agents and Adjuvants

Local anaesthetics (LAs) are essential components for topical, local and block anaesthesia. LAs had been first introduced to clinical practice for ophthalmic anaesthesia. Topical administration of cocaine as the first LA agent by Karl Koller opened a new era in surgical anaesthesia.

LAs act on the cell membrane to prevent the generation and the conduction of nerve impulses. Their main action site is voltage-gated Na^+ channels. The open and inactivated states of voltage-gated Na^+ channels have higher affinity to LA drugs than the resting state. In ophthalmic practice, reversibly blocking Na^+ channels inhibits painful nerve impulses from the cornea, conjunctiva, sclera, and orbital tissues.

Local anaesthetics are poorly water-soluble and weak base molecules. However, commercially available LAs are generally water-soluble salts to increase the stability of the LA, but LAs become more charged in these mildly acidic solutions. Higher concentrations ensure rapid onset, whereas lipid solubility allows a greater potency. However, the onset of action of LA also depends on the route of administration and dose of the drug, while the longer duration of effect depends on the higher protein binding. All LAs contain an aromatic ring (hydrophobic part), an intermediate ester or amide bond and an amino group (hydrophilic part). LAs may be classified into two groups according to their chemical formulation as ester type and amide type LAs. Ester type LAs are metabolised by plasma esterase, such as plasma cholinesterase, whereas amide type LAs are degraded by the hepatic cytochrome P450.

In clinical practice, LAs can be grouped into three groups according to their duration of action: short (approximately 20–45 minutes) such as procaine, intermediate (approximately 60–120 minutes) such as lidocaine, mepivacaine and long (more than 2 hours) including bupivacaine, ropivacaine, and tetracaine. The chemical and clinical features of commonly used LAs in oculoplastic procedures are as follows:

Ester Type LAs

Cocaine has a historical significance and is known to the first non-synthetic local anaesthetic used in ophthalmic practice. It has an intense vasoconstrictor feature different than other LAs. Its use as an LA is nearly abandoned due to its many undesirable effects during anaesthesia as well as substance abuse potential.

Tetracaine (amethocaine) is a highly potent, intermediate-acting local anaesthetic which is mostly used topically at 1% concentration in an aqueous form. It has a higher toxicity potential and repeated administration may also cause corneal epithelial impairment. It causes a burning sensation and pain during administration, which can be alleviated by cooling the solution.

Proparacaine hydrochloride is a short-acting LA, commonly used for topical administration. It is formulated in 0.5% aqueous solution. Its effect onsets within seconds and continues for approximately 15 minutes. Its burning sensation is reported to be less than tetracaine. Due to a rare, but severe and hypersensitivity reaction, it may cause large areas of necrotic epithelium, ground-glass appearance, and erosion of the cornea.

Oxybuprocaine is an ester-type local anaesthetic which is used extensively for topical anaesthesia in 0.4% concentration.

Amide Type LAs

Lidocaine is the most commonly used LA for oculoplastic procedures with its predictable and rapid onset (approximately 60 seconds), duration of action up to an hour and unexpected risk of toxicity. Its maximum dose is 4 mg/kg when administered alone and 7 mg/kg with epinephrine. It provides 30–60 minutes of action without epinephrine. This duration may be prolonged up to 2–4 hours with the addition of epinephrine. Its concentration is 4% during topical administration and total dose may be as high as 5 mg/kg during tumescent anaesthesia. Therefore, the patient should be monitored attentively for the possible risk of systemic toxicity since systemic absorption of the topically and tumescent applied drugs is relatively very high. Lidocaine in gel form is also efficient in providing anaesthesia in a dose-dependent manner. Lidocaine is also effectively used for subconjunctival, transconjunctival and intracameral application.

Prilocaine is an intermediate-acting LA very similar to lidocaine. It is administered at 2–4% concentrations for infiltration and topical anaesthesia, respectively. It is also available in a eutectic mixture of local anaesthetics with lidocaine, which is commonly used to alleviate the pain before LA injections to eyelids and periocular botulinum toxin injection. High doses of prilocaine exceeding 7 mg/kg or a total dose of 500 mg lead to methemoglobinemia as a sign of systemic toxicity which should be treated with methylene blue in a dose of 1–2 mg/kg (except in patients with known G6PD deficiency) and ascorbic acid (vitamin C).

Bupivacaine is a highly lipid-soluble and potent agent with slow onset (10–25 minutes) and prolonged duration of action (up to 6–8 hours) with a narrow therapeutic index. It has a severe cardiotoxicity potential above its maximum dose of 2–3 mg/kg.