Anaesthesia in Oculoplasty

Oya Yalcin Cok and Ezzat Sami Aziz

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.

O. Yalcin Cok (✉)
Department of Anaesthesiology and Reanimation, School of Medicine, Adana Research and Education Center, Baskent University, 01250 Adana, Turkey
e-mail: oyacok@yahoo.com

E. S. Aziz
Department of Anaesthesiology, Cairo University, Giza, Egypt

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.

E. A. El Toukhy (ed.), *Oculoplastic Surgery*, https://doi.org/10.1007/978-3-030-36934-7_2

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

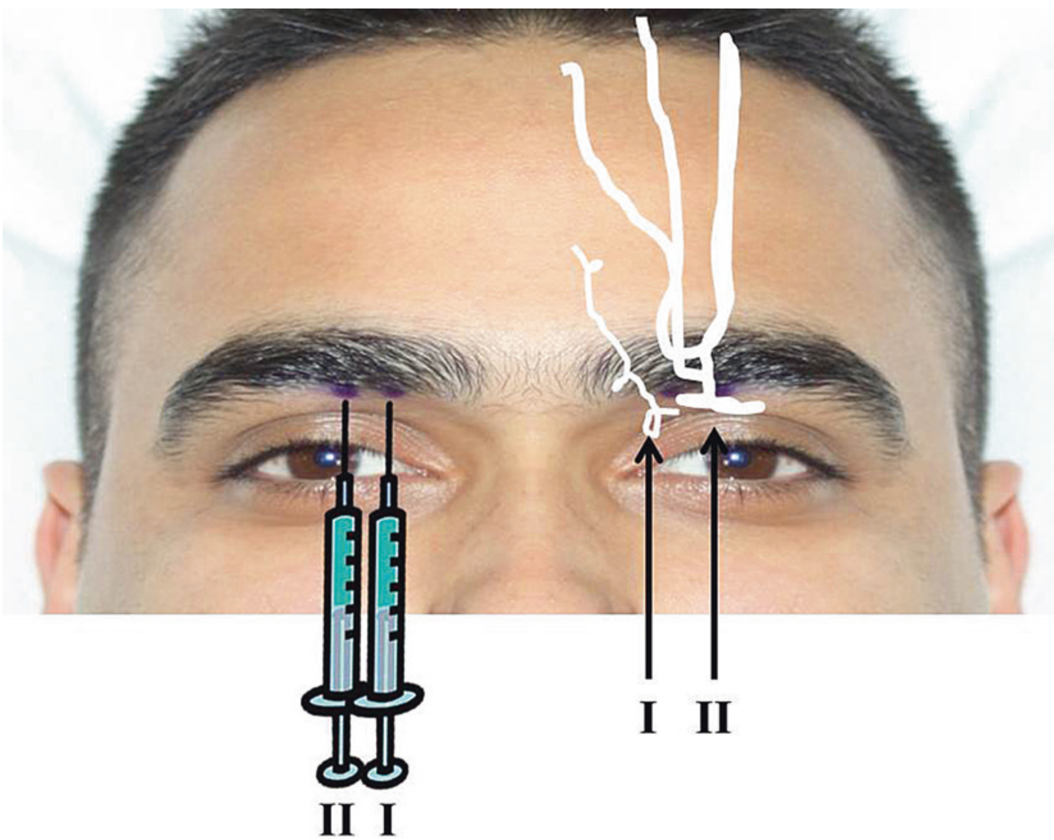

Fig. 1 The supratrochlear and the supraorbital nerves and the respective block sites. I: The supratrochlear nerve, II: The supraorbital nerve

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.

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).

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

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

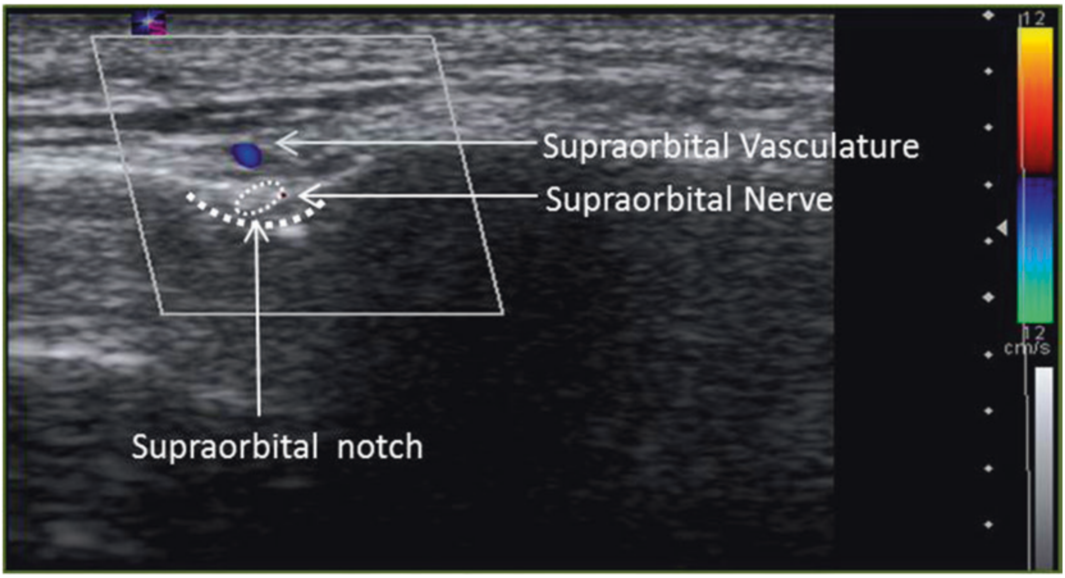

Fig. 3 Ultrasound image for supraorbital nerve block

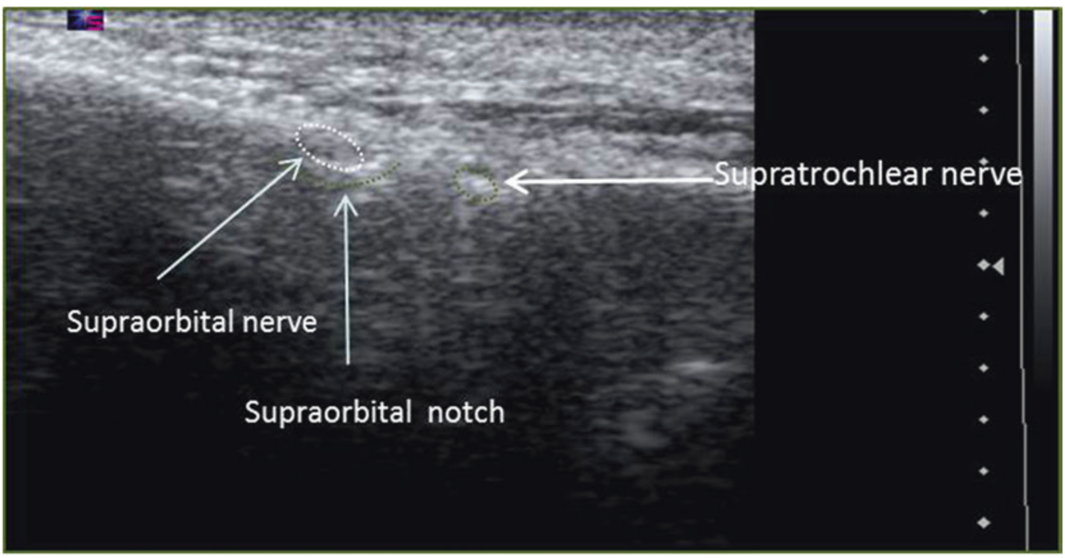

Fig. 4 Ultrasound image for supratrochlear nerve block

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.

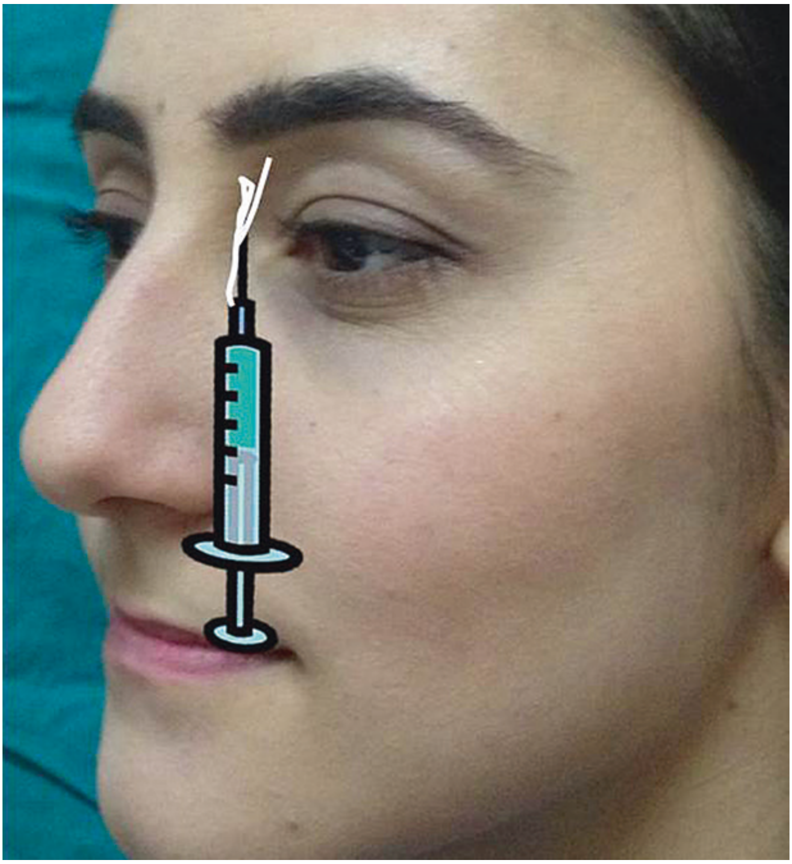

Fig. 5 Infratrochlear nerve and the block site

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,

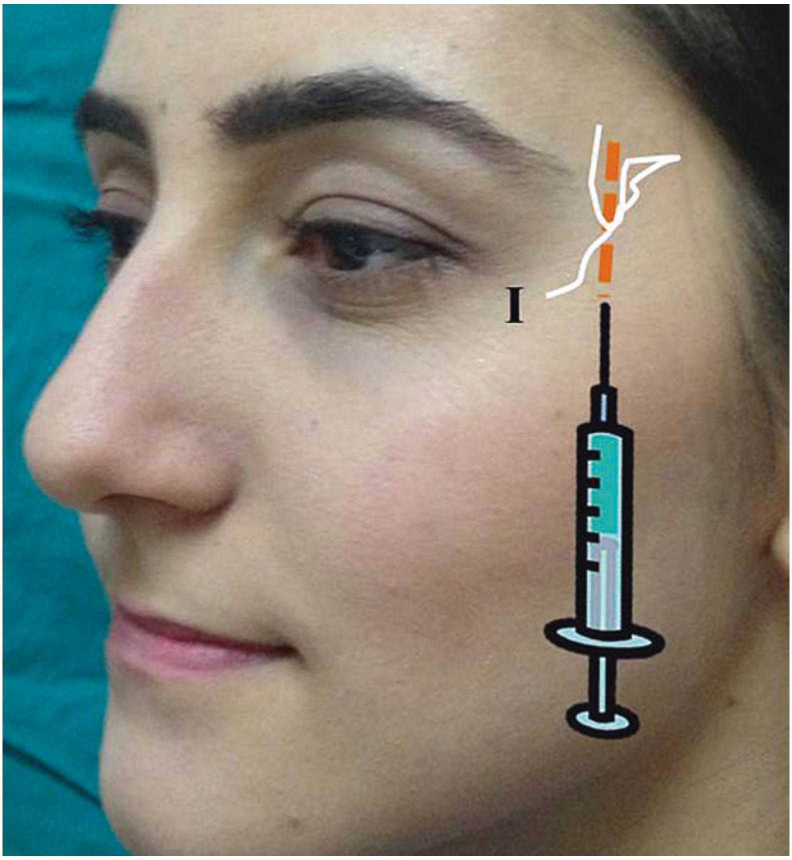

Fig. 6 The zygomaticotemporal nerve and the block site. I: The zygomaticotemporal nerve

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.

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).

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

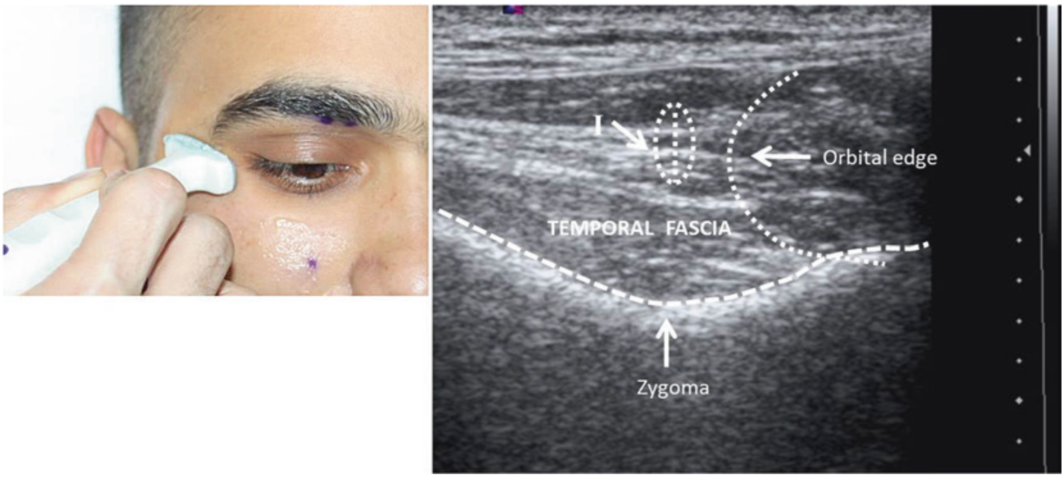

Fig. 7 Ultrasound image for zygomaticotemporal nerve block. I: The zygomaticotemporal nerve block LA injection site

Fig. 8 Infraorbital nerve block site with percutaneous extraoral approach

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.

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.

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

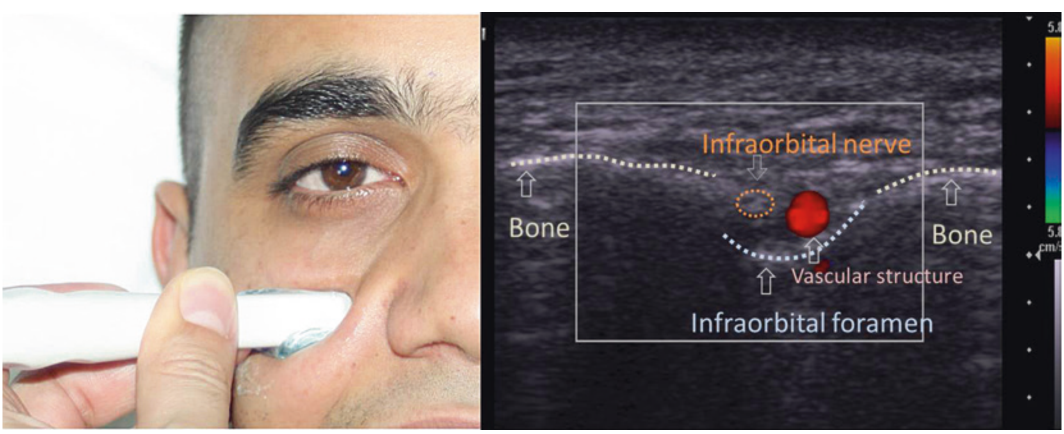

Fig. 9 Ultrasound image for infraorbital nerve block

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.

Levobupivacaine is the pure S (-) isomer of bupivacaine. Its clinical features are very similar to bupivacaine, however, with less potential cardio- and neurotoxicity.

Ropivacaine is an LA similar to bupivacaine with slow onset and long duration of action; however, its cardiac toxicity and potency are less than bupivacaine. It is used in 0.75–1% concentrations for topical, local and block anaesthesia.

Etidocaine is used in 0.5–1.5% concentration enabling rapid-onset, prolonged duration, and intense motor blockage during ophthalmic regional anaesthesia.

Mepivacaine used at 2–3% concentrations in ophthalmic practice, is similar to lidocaine with longer duration of action.

Adjuvants have been added to LAs to provide an early onset, longer duration, less pain during injection, less bleeding and less systemic effects.

LAs are frequently accompanied with ***epinephrine*** (1:100.000–400.000) to slow down the systemic absorption and decrease bleeding during oculoplastic procedures. Duration of action may be prolonged by 50% when epinephrine is added to intermediate-acting and natural vasodilator LAs. However, adding epinephrine to long-acting LAs usually do not provide the advantage of longer duration but only less bleeding and less systemic absorption. Addition of epinephrine to the local anaesthetics before infiltration enables less bleeding during the surgery and this practice reaches maximal haemostatic effect in 7 minutes and waiting longer doesn't offer a further decrease in bleeding. Periocular injections with epinephrine are a relatively contraindicated in patients with untreated narrow angles because of pupillary dilation. It should also be kept in mind that the use of vasoconstrictors with LA during ophthalmic surgery may also reduce retinal artery blood flow and lead to vision loss and this should be avoided during retrobulbar, peribulbar, sub-Tenon blocks and during regional administrations close to vascular structures. Lower concentrations of epinephrine may help avoid such complications.

Sodium bicarbonate is another adjuvant used with LAs to increase the pH of them to accelerate the onset of action slightly and alleviate injection pain. It is reported to be used in a ratio of 1: 10–31 (sodium bicarbonate: LA). However, it may cause precipitation of the solution.

General Anaesthesia

Sedation and general anaesthesia management are not very detailed for oculoplastic surgeries. Sedoanalgesia with short-acting benzodiazepines such as midazolam and opioids such as alfentanil and remifentanil for oculoplastic surgery under local anaesthesia enables low pain scores and high patient satisfaction as well as maintaining the requirements of outpatient setting. Ketamine is an NMDA receptor antagonist and provides a dissociative state when administered. The main advantages of ketamine are its good analgesic potency and minimal effect of respiration; however, it may cause agitation and hallucinations when it is not accompanied by a benzodiazepine. Propofol may also be used at sedative doses while periocular LA injections. Monitored anaesthesia care has been reported to provide effective anaesthetic conditions even for enucleations and eviscerations.

General anaesthesia techniques must meet a few particular needs of oculoplastic surgery. In terms of hypnotics, any intravenous and inhalation anaesthetics can be used to provide induction and maintenance of the general anaesthesia. Total intravenous anaesthesia may provide the advantage of rapid recovery and discharge from the hospital. Laryngeal mask airway insertion or intubation may secure the airway effectively and can be used according to the operation site if there is no emergency case with a full stomach. The use of neuromuscular blocking agents is frequently limited to non-depolarizing ones. Patients undergoing oculoplastic surgery under general anaesthesia experience postoperative pain and discomfort by 32.1% and 28.3% respectively. Anxiety, prior surgery in the eye and smoking are the predictors of postoperative pain and discomfort following general anaesthesia in this patient population. Management of preoperative anxiety, postoperative pain, and prevention of postoperative nausea and vomiting should be an essential part of the anaesthetic plan. The main recommendation for sedation and general anaesthesia is the existence of a physician, preferably an anaesthesiologist, monitoring and managing the patient.

Challenges of Anaesthetic Management During Oculoplastic Surgery

Specific anaesthetic challenges during lacrimal, orbital and oculoplastic surgery must also be highlighted. These issues include challenging patients and challenging procedures.

Challenging Patients

The patients' anaesthetic needs have been expected to be low for many oculoplastic surgeries which are performed at an office setting. However, the patients undergoing surgery due to oculoplastic disorders may be too young, too old, or may have serious co-morbidities. These patients may have increased malignant hyperthermia risk due to neuromuscular disorders, considerable hormonal alterations, or metabolic disorders, systemic manifestations of malignancies which may affect anaesthetic management.

The patients with ptosis and strabismus who may have oculoplastic surgery are specifically at risk of ***malignant hyperthermia*** (MH). MH is an autosomal dominant disorder of skeletal muscle, mostly caused by a defect in the ryanodine receptor. It is a hypermetabolic response triggered by inhalational anaesthetics and succinylcholine, a depolarizing muscle relaxant. The incidence has been reported to range from 4 to 100 in one million cases. The clinical signs of MH include hyperthermia, tachycardia, tachypnea, increased end-tidal carbon dioxide, acidosis, hyperkalemia and muscle rigidity. Increased oxygen consumption and rhabdomyolysis also co-exist. The risk of malignant hyperthermia may jeopardize or alter general anaesthesia plans. Detailed family history regarding general anaesthesia and related mortality is essential during the preoperative assessment of these patients. Early suspicion and recognition of the MH is the key for immediate treatment. General anaesthesia may be acceptable when precautions are in place with close follow-up. However, regional anaesthesia techniques should be preferred if possible especially in patients with concomitant neuromuscular or metabolic diseases such as Kearn-Sayre Syndrome. When MH is initiated, the management plan includes cessation and removal of the inhalational anaesthetics, external cooling, and supportive therapy and, mainly, the administration of dantrolene sodium. Increased understanding of the pathophysiology and better intraoperative monitoring systems enabled a considerable decrease in mortality the last few decades.

The patients with ***thyroid eye disease*** may also represent a challenge for anaesthetic management. These patients usually undergo orbital decompression surgery. They may present to the operating room with considerable hormonal alterations since both hypo- and hyperthyroidism has ophthalmic manifestations. Both disorders may affect the eye and surrounding tissues via auto-immunity by antibodies to eye muscles and fat tissue. These patients should have thyroid function tests preoperatively to check euthyroidism which is the preferred state. Elective surgery should be deferred until the patient has been rendered euthyroid and appropriate medication has started to control cardiovascular response due to disease. During anaesthetic management of hyperthyroid patients, the agents that can stimulate the sympathetic nervous system, such as pancuronium, ketamine, direct and indirect adrenergic agonists, should be avoided. Exaggerated hypotensive response during induction may be observed, however exaggerated hypertensive response is also possible due to inadequate anaesthetic depth before laryngoscopy or any surgical stimulation. Epinephrine should not be added to local anaesthetics. In patients with hypothyroidism, increased sensitivity to anaesthetic agents, delayed recovery, hypothermia, poor tolerance to blood loss are expected. Inhalational anaesthetics may exaggerate cardiac depression in very symptomatic hypothyroid patients. Neuromuscular monitoring is also recommended for titrating neuromuscular blocking agents and timing of tracheal extubation in these patients. Opioids should be used attentively. Another concern in thyroid eye disease patient is difficult airway management due to tracheal compression or deviation by overgrown thyroid gland or tumour. Patients should be evaluated for difficult ventilation and/or intubation preoperatively and difficult airway management measures should be readily available in the setting.

Patients with orbital tumours with systemic malignancies or systemic tumours with orbital metastasis may also need ophthalmic surgery. Especially, melanoma has cardiac involvement which is usually in the right chambers of the heart. On the other hand, renal cell carcinoma, breast cancer, angiosarcoma, lymphoepithelioma, and hepatocellular carcinoma have been reported to have orbital metastasis. Here, the primary disease and its systemic effects are the major concerns during anaesthesia. These patients should be evaluated individually and the anaesthetic management should be tailored accordingly.

Challenging Procedures

One of the brief but challenging procedures is ***probing and nasolacrimal intubation***. It is the most frequent lacrimal operation in children. Tracheal intubation, laryngeal mask airway, and mask ventilation are possible ways to secure ventilation. Although this a very brief intervention in experienced hands, the main concern during this procedure are sharing the airway with the surgeon and the possible risk of aspiration of blood or saliva when the airway protective devices aren't used during a sedation technique. General anaesthesia with inhalational or intravenous anaesthetics is both feasible. However, only sedation is mostly the frequent anaesthetic technique at an office-based setting, which is practical as well as highly satisfying according to the parents. Probing and nasolacrimal intubation is also one of the rare ophthalmic surgeries possibly indicating infection prophylaxis for endocarditis in patients at high risk, however the results of the studies about the issue are still controversial.

Another procedure that needs more attentive anaesthetic management is ***orbital fracture surgery***. Orbital surgeries often present as an emergency due to trauma which occurs frequently with the problem of full stomach and underevaluation of the patient. A difficulty in airway management such as insufficient mask ventilation or unsuccessful intubation as well as a need for fast induction and smooth intubation may co-exist. The patients with orbital fractures may also have concomitant intracranial pathologies or dural tears. The anaesthesia measures during these surgeries must also meet the needs of neuroprotection.

Enucleation, ***evisceration, exenteration and socket reconstruction*** may also represent a challenge for anaesthesia and ophthalmology teams since patients may experience severe postoperative nausea and vomiting and pain. These adverse events prevent early discharge from the hospital. Postoperative acute pain is usually localized to the remaining orbit and responds well to paracetamol, NSAIDs, and opioids. Perioperative regional techniques may also provide efficient pain relief. In the late postoperative period, phantom eye syndrome may be present as any sensation as originating in the eye despite it was amputated. These sensations include painful sensation such as cutting, penetrating, shooting or superficial burning pain, itching, feeling of non-existent eyelids and visual hallucinations. The medical therapy frequently consists of tricyclic antidepressants, anticonvulsants, ß-blockers, IV calcitonin, NMDA antagonists and rarely opioids.

Summary

Anaesthetic management for oculoplastic surgeries mainly requires a thorough knowledge of anatomy, local anaesthetic pharmacology, and particular adjustments according to the specific needs of the surgery. Periocular blocks usually provide intraoperative anaesthesia and postoperative analgesia effectively; however, general anaesthesia is still a custom practice for a specific patient population such as children and specific surgeries such as dacryocystorhinostomy.

Suggested Readings

1. Moody BR, Holds JB. Anesthesia for office-based oculoplastic surgery. Dermatol Surg. 2005;31:766–9.
2. Ing EB, Philteos J, Sholohov G, Ta Kim D, Nijhawan N, Mark PW, Gilbert J. Local anesthesia and anxiolytic techniques for oculoplastic surgery. Clin Ophthalmol. 2019;13:153–60.
3. Bartamian M, Meyer DR. Site of service, anesthesia, and postoperative practice patterns for oculoplastic and orbital surgeries. Ophthalmology. 1996;103:1628–33.
4. Vagefi MR, Lin CC, McCann JD, Anderson RL. Local anesthesia in oculoplastic surgery. Arch Facial Plast Surg. 2008. https://doi.org/10.1001/archfaci.10.4.246.
5. Lalatsa A, Emeriewen K, Protopsalti V, Skelton G, Saleh GM. Developing transcutaneous nanoenabled anaesthetics for eyelid surgery. Br J Ophthalmol. 2016;100:871–6.
6. Ahn ES, Mills DM, Meyer DR, Stasior GO. Sneezing reflex associated with intravenous sedation and periocular anesthetic injection. Am J Ophthalmol. 2008;146:31–5.
7. Ascaso FJ, Peligero J, Longás J, Grzybowski A. Regional anesthesia of the eye, orbit, and periocular skin. Clin Dermatol. 2015;33:227–33.

8. Ismail AR, Anthony T, Mordant DJ, MacLean H Regional nerve block of the upper eyelid in oculoplastic surgery. Eur J Ophthalmol 16:509–13.
9. Barnett P. Alternatives to sedation for painful procedures. Pediatr Emerg Care. 2009;25:415–9.
10. Herlich A. Focused local anesthesia and analgesia for head and neck surgery. Int Anesthesiol Clin. 2012;50:13–25.
11. Burroughs JR, Soparkar CNS, Patrinely JR, Kersten RC, Kulwin DR, Lowe CL. Monitored anesthesia care for enucleations and eviscerations. Ophthalmology. 2003;110:311–3.
12. Yen KG, Elner VM, Musch DC, Nelson CC. Periocular versus general anesthesia for ocular enucleation. Ophthal Plast Reconstr Surg. 2008;24:24–8.