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Opioid-Free General Anaesthesia for Vitreoretinal Surgery with Scleral Buckling: Applying ERAS Strategies to Ophthalmic Surgery

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Abstract

The case report describes a modified enhanced recovery after surgery (ERAS) strategy for scleral buckling surgery, a type of vitreoretinal surgery, using a combination of Sub-Tenon's block (STB) and opioid-free multimodal anaesthesia. Generally, scleral buckling surgery is performed under general anaesthesia with opioids due to the prolonged duration of surgery and potential tissue destruction leading to post-operative pain. However, complications associated with local anaesthesia and the use of opioids create the need to develop modified ERAS protocols in ophthalmic surgery. We present the case of a patient scheduled for 23 G vitrectomy with scleral buckling, exocryocoagulation and gas endotamponade to treat macular retinal detachment. We provided electroencephalogram-controlled, multimodal, opioid-free anaesthesia for this patient, combined with Sub-Tenon's block.

Keywords: *Sub-Tenon's block, multimodal a*naesthesia*,* opioid-free anaesthesia*,* electroencephalogram-controlled *a*naesthesia, ERAS strategy for scleral buckling surgery, ophthalmic anaesthesia.

Abbreviations

- ERAS: enhanced recovery after surgery
- EEG: *electroencephalogram*
- *STB: Sub-Tenon's block*
- ASA: American Society of Anaesthesiologists
- PONV: Postoperative Nausea and Vomiting
- BP: blood pressure
- mmHG: millimeter mercury
- bpm: *Beats per minute*

Introduction

Most vitreoretinal surgeries are performed on an outpatient basis. Scleral buckling surgery involves the closure of retinal breaks and the reduction of vitreoretinal tractions through the suturing of buckling elements onto the scleral surface and ensuring a proper chorioretinal adhesion through retinopexy. The surgery requires careful localisation of all retinal breaks and the proper selection and placement of radial or circumferential explants to seal the breaks properly, with additional steps such as cryotherapy or laser photocoagulation and evacuative puncture for better results. Historically, this type of vitreoretinal surgery was mainly performed under general anaesthesia with a resort to opioids due to the prolonged duration of surgery, the need for a motionless field, the intensity of the surgical stimulus and the potential tissue destruction. Consequently, this surgery carries a risk of high post-operative pain when compared to a standard vitrectomy. Although there has been a trend towards vitreoretinal surgeries being completed under monitored anaesthesia care with local anaesthetic blocks, complications secondary to local anaesthesia (peribulbar or retrobulbar) are rare but very serious. These include retrobulbar haemorrhage, penetration or perforation of the globe, optic neuropathy, diplopia secondary to muscle injury and respiratory arrest because of dural sheath inoculation with subsequent brainstem anaesthesia. Additionally, when a patient is anxious or additional sedation is needed, propofol, morphine-class analgesics, and benzodiazepines are not a substitute for analgesia. Excessive sedation can become counterproductive due to the increased risk of disinhibition with increased patient movement and poor patient compliance.

So far, many subspecialties have formulated ERAS (enhanced recovery after surgery) protocols to facilitate swift recovery [1]. While some elements of ERAS might not be easy to apply in ophthalmic surgery due to its less invasive nature, other elements, particularly locoregional anaesthesia, use of propofol, dexmedetomidine and ketamine, as well as *electroencephalogram (EEG)*-guided dosing can be effective. Since ophthalmic patients are often old and frail, these elements could play an essential role in developing future ERAS protocols in ophthalmic surgery. We describe a modified ERAS strategy in ophthalmic surgery by combining *Sub-Tenon's block* (STB) with opioid-free multimodal anaesthesia [2].

This manuscript adheres to the applicable EQUATOR guidelines. Written consent has been obtained from the patient to publish this case report.

Case presentation

We present the case of a 54-year-old female ASA 2 (American Society of Anaesthesiologists) patient scheduled for 23 G vitrectomy, encircling band, exocryocoagulation and gas endotamponade to treat macula-off retinal detachment. She presented to the hospital with retinal tear symptoms 36 hours before surgery. Her medical history included migraines and substituted hypothyroidism. The patient weighed 45 kg and was 150 cm tall. Apart from anxiety caused by the current medical condition, our patient had undergone anaesthesia for a caesarean section 20 years earlier, with significant PONV on every following surgery. Given her anxiety, she opted for general anaesthesia during her planned retinal detachment surgery.

Our patient arrived at the ophthalmic operating theatre agitated and very nervous, with cold hands, contracted subcutaneous veins, blood pressure (BP) of 90/50 mmHg, and heart rate of 69 beats per minute (BPM). Previously, she had received 500 mg paracetamol orally in the outpatient clinic as part of a preemptive approach to analgetic medication. The anaesthetist in charge (FL) urged the patient to imagine herself in a safe place. She chose a beautiful beach and described the landscape and reassuring sensory input throughout the preparation for anaesthesia. Her regular ASA monitoring was extended by a 1-channel, three-electrode EEG (Narcotrend, Hannover, Germany) mounted on the left side of the forehead (10:20) with the reference electrode over the left mastoid.

After a slow bolus of 20 mcg of dexmedetomidine iv (0.4 mcg/kg), we induced anaesthesia with propofol 2.5 mg/kg iv, lidocaine 0.5 mg/kg and ketamine 0.75 mg/kg. After obtaining a negative bilateral corneal reflex, assuring us of a quiescent brain stem, we inserted a no. 3 laryngeal mask without difficulty. A STB was administered 2 mm peripheral to the inferonasal limbus (see Fig 1), with 3 ml ropivacaine 1% mixed with 2 ml mepivacaine 1%, 15 mcg clonidine and 30 IE hyalase. During the block administration, our patient's heart rate increased by about ten percent, and she grimaced slightly for 2 minutes. These reactions abated swiftly, and glycopyrrolate was administered to safeguard against oculocardiac reflexes.

At the start of surgery, the EEG was rich in 100 µV-amplitude, 12 Hz-spindles overriding regular slow waves and a corresponding spectrogram (see Fig.2). While the surgeons isolated the straight extraocular muscles, no changes in heart rate occurred, but the pressure-volume curves shown on the ventilator diminished by about 30%, prompting us to administer another bolus of ketamine at 15 mg. Ventilation remained undisturbed thereafter. Propofol infusion was kept steady at 7.2 mg/kg/h. While the extensive vitreoretinal surgery was undertaken, ketamine and lidocaine were simultaneously infused at 0.4 mg/kg/h. An infusion of 2 g magnesium iv in 100 ml NaCl 0.9% was given. At the end of the surgery, during conjunctival suturing, the propofol infusion was gradually reduced, and the lidocaine and ketamine infusions were discontinued. Spontaneous respiration ensued. Propofol infusion was stopped with the last conjunctival suture, and the laryngeal mask was removed two minutes afterwards.

Discussion

Correct timing of the STB directly before the initial surgical steps (peritomy, isolation of ocular muscles) is essential in rendering opioids unnecessary. Our experience from other cases demonstrates well that if the ophthalmic surgeon administers STB only after peritomy, the opening of Tenon's space and isolation of the straight eye muscles, a systemic analgesia bolus is required in the form of either opioids or more ketamine. The STB is usually performed very close to the inferonasal limbus (see Figure 1).

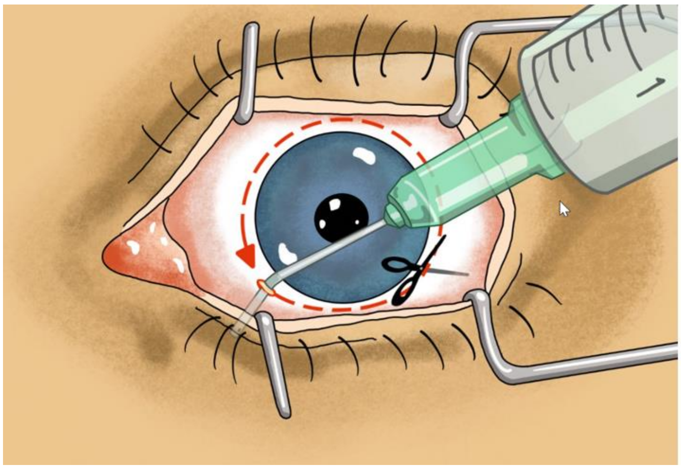


Figure 1: Sub-Tenon's block performed via a small incision close to the limbus in the inferonasal quadrant. From this incision peritomy can be issued. The advantage of this method is that STB reliably provides analgesia to cover both peritomy and isolation of ocular muscles, rendering systemic analgesia unnecessary. An additional benefit is that STB severs the oculocardiac reflex arch often triggered during this surgical step.

Figure 1: technique of Sub-Tenon’s block

This is contrary to usual practice, in which STB is administrated 5-10 mm away from the limbus. The procedural safety of a blunt cannula STB lends itself particularly well to administration with the patient already under anaesthesia. In this case, the limbal approach allowed the surgeon to issue the 360° peritomy of the conjunctiva and Tenon's fascia and severing the oculocardiac reflex arc with the STB. No bradycardia emerged during traction of the ocular muscles for placement of the encircling band [3], but interestingly, ventilator pressure/volume loops acutely decreased for 3 minutes and then spontaneously recovered [4]. In our practice, we see more oculocardiac reflexes when performing STB after peritomy.

Intravenous lidocaine has a proven opioid-sparing effect and is useful in keeping intraocular pressures under control during surgery [5,6]. The positive effects of magnesium on postoperative opioid requirements have been proven for many surgical procedures [7]. However, the effect of magnesium on perioperative pain and the necessity for opioid use in ophthalmic surgery has not yet been investigated. Ketamine is a strong analgetic, anti-inflammatory and anti-depressant known for its hallucinogenic potential. This latter complication is rarely seen when ketamine is combined with alpha-2-agonists and propofol. In the case described above, the recorded perioperative frontal EEGs showed a clear ketamine signature that can be counteracted by increasing propofol infusion, aimed at keeping the psychedelic effects of ketamine under control. Contrary to common belief, it has been shown that ketamine is not associated with a clinically relevant rise in intraocular pressure [8], especially in combination with dexmedetomidine, lidocaine and propofol. Dexmedetomidine has been widely used in ophthalmic anaesthesia. Apart from being a propofol-reducing co-sedative, it is an opioid-reducing co-analgetic drug. It significantly reduces intraocular pressure. It is important to stress that the pharmacological components of multimodal anaesthesia must be balanced with care and within therapeutic doses to avoid severe side effects.

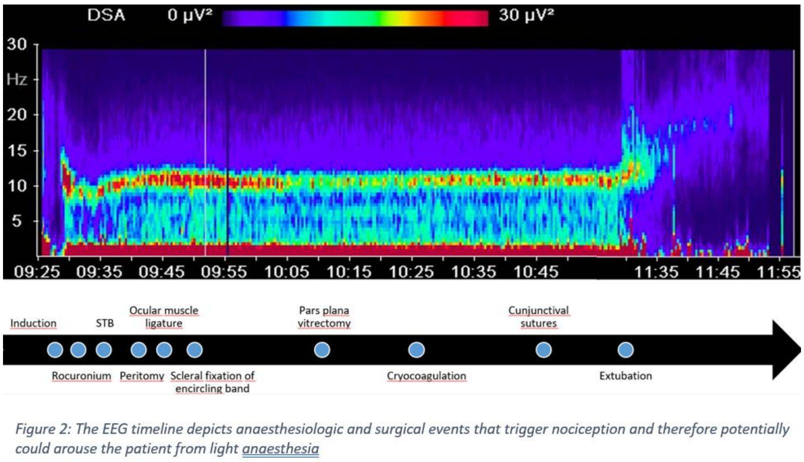
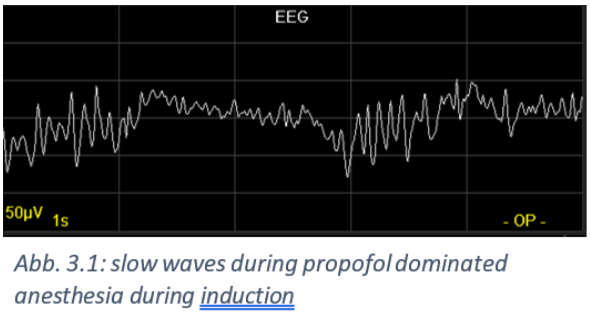


Figure 2: EEG timeline with anaesthesiologic and surgical events.

The characteristic perioperative EEG of this combined opioid-sparing anaesthesia is remarkable because they are spindle-rich, often including a high degree of frequencies above the usual alpha (9-12 Hz) domain. With the addition of ketamine and magnesium to propofol and dexmedetomidine, a distinct shift to lower beta frequencies with a slight decrease in delta power can be observed. In the raw EEG, the characteristic propofol spindles (high amplitude, duration >1-1.5 sec, 8-12 Hz) are replaced by shorter crescendo-decrescendo patterns around 0.5 sec long, the amplitude of 25-50 µV and a frequency around 15 Hz. These could be called "ketamine-spindles" (see Figure 3.1 and 3.2).



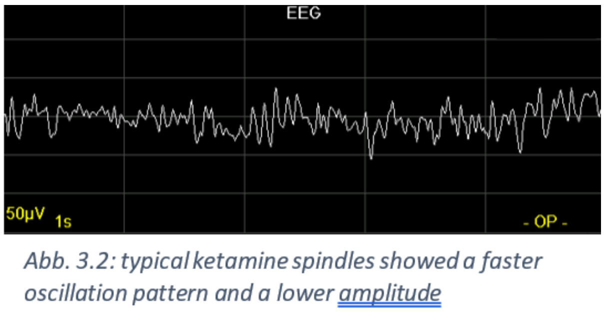


Figure 3.1: raw EEG with slow waves during propofol dominated anaesthesia; **Figure 3.2:** raw EEG with typical ketamine spindles.

Combining general anaesthesia with locoregional anaesthesia is a well-established strategy to reduce anaesthetic and opioid use, decrease the risk of postoperative nausea and vomiting, and provide better perioperative pain control [9,10,11]. Using a multimodal approach may help further to reduce undesirable side effects of anaesthetic agents and opioids. We believe the EEG is an effective addition to monitoring and controlling anaesthesia. We are aware that available data on EEG-controlled anaesthesia and multimodal opioid-free anaesthesia is still insufficient since there is a shortage of large, randomised clinical trials.

Conclusion

In this case, the patient expressed relief at not having suffered nausea and vomiting and spontaneously reported a complete lack of brain fog after her ophthalmic retinal detachment surgery.

In our experience, locoregional anaesthesia combined with EEG-controlled multimodal general anaesthesia is a safe and effective method for vitreoretinal surgery. This approach helps to reduce unwanted drug-related side effects and offers good pain control during and after surgery and therefore could be part of future ERAS protocols in ophthalmic surgery.

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Author's individual contributions:
-Federico Ebert: This author drafted the manuscript.
-Caitlin Douglas: This author helped with the figures of the manuscript.
-Chantal Dysli: This author helped with the writing of the manuscript.
-Jan Darius Unterlauft: This author helped with the writing of the manuscript and performed the surgery.
-Joana Berger-Estilita: This author helped with the writing of the manuscript.
-Friedrich Lersch: supervised the project, the main conceptual ideas and outline.

All authors discussed, corrected and approved the final version of the manuscript.

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