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ANESTHESIA FOR OPHTHALMOLOGIC PROCEDURES

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This type of anaesthesia requires special considerations resulting from the procedure, to the state of the eyeball, age and concurrent diseases in the patient (i.e. geriatrics, diabetic). During these surgical procedures, there are restrictions in the surgical space that difficult access to the patient and the venous access (catheterisation is better in the hindquarters and in those breeds where possible, in the ear) that may complicate management and monitoring. It may be necessary to use methods of neuromuscular blockage to fix and focus of the eyeball for the surgery, which will mean the use of specific monitors and mechanical ventilation equipment. We must also assess pathophysiological aspects crucial in this type of anaesthesia, especially in those cases where there is a risk of ocular rupture (deep corneal ulcers) and in the face of intraocular procedures such as cataracts. Many of these procedures are easier if anaesthesia provided or avoided:

- Increases in intraocular pressure.
- Control of oculocardiac reflex.
- Fixed and centred eyeball in the orbit.
- Smooth inductions/recovery.
- Proper analgesia/antinociception.
- Interference with concurrent treatments.

Intraocular Pressure (IOP)

Intraocular pressure is influenced by elevations in the central venous pressure (CVP), blood pressure, external compressions, increases in PaCO₂ and by the action of various drugs. The increase in IOP leads to an increased risk of ocular rupture in severe cases (deep ulcers, traumatic ruptures). Virtually all anaesthetics reduce IOP except ketamine¹,², even in combination with benzodiazepines. It is important to control IOP and prevent its increase indirectly through cough attacks, nausea or vomiting that increase the CVP. In these cases, there is the emetic potential of morphine and medetomidine. In nervous or aggressive patients excitement during handling may also increase IOP, so that sometimes can be considered the use of low doses of medetomidine or dexmedetomidine for better control of these cases. The use of atropine did not seem to affect significantly the IOP, but in general it is advisable to avoid it in cases of glaucoma. It should be considered the application of topical or intravenous lidocaine to reduce the adverse reaction to the orotracheal intubation. Similarly, the use of low doses of fentanyl at induction reduces the risk of cough during this manoeuvre. Succinylcholine cause contractions of the extraocular muscles and cause dramatic elevations in IOP, which reaches its peak during the period of contractions prior to the establishment of paralysis. By contrast, administration of non-depolarizing blockers, in common use nowadays, tends to reduce the IOP. The patient’s position is important, the neck needs to be kept in proper place and slightly raised, while direct compressions of the jugular needs to be avoided as they can increase the IOP.

Good analgesic coverage guarantees that there will be no increases in the IOP due to raises in the mean arterial pressure (MAP > 110). It is also necessary to keep the patient properly ventilated as hypercapnia increases the ocular perfusion and raises the IOP. The use of hyperventilation techniques under mechanical ventilation, reduces ocular perfusion and in theory the IOP. However, the increase in intrathoracic pressure during inspiratory phase to positive pressure can act in the opposite direction. It is essential to find the right balance, maintaining moderate peaks of inspiratory pressure to minimize these effects. If necessary, especially in ocular emergencies, the IOP can be reduced through the use of 20% mannitol solutions (0.25-0.75 gr/Kg). Finally, consider that the use of sclerotic traction sutures to elevate the eyeball, without using NMB’s, can cause increases in IOP.

Oculocardiac reflex
This reflex causes increased vagal tone, causing arrhythmias, severe bradycardia and even asystole. It
occurs when you apply pressure or traction on the eyeball and its extrinsic muscles. It is rare in adult dogs, and a study in 72 dogs subjected to various ocular surgeries, described it in a single case. This work concluded that this reflex is clinically irrelevant in adult dogs, provided that anaesthesia produces good hypnosis, good muscle relaxation and mild hypocapnia. Parasympathomimetic drugs administration like atropine or glycerolized allow the control therapeutically. In young patients with higher vagal predominance, its impact could be higher especially in aggressive procedures like enucleation. Retrobulbar blockage eliminates its appearance but it is not free of complications. If detected during surgery, we must stop the surgical manipulation immediately, assess the level of anaesthesia and muscle relaxation to correct if they are not adequate, and atropine is administered intravenously if required.

**Position of the eyeball**

During surgical anaesthesia the eyeball usually rotate in dogs and cats ventromedially, unless ketamine is used to maintain anaesthesia. An eyeball centred, fixed and immobile can be achieved using neuromuscular blockers (NMB’s) as we mentioned. The blockage technique facilitates performance of various procedures at corneal and intraocular level. For its part, the application of retention/traction sclerotic sutures, retrobulbar blockage or induction of deep anaesthesia levels as alternative to the use of NMB’s present several risks. The most commonly used type of blockers are non-depolarizing like atracurium (0.25 mg/kg). Start action: 2-5 minutes. Duration: 20-30 minutes. Repeated dose: 0.1 mg/kg), cis-atracurium, rocuronium or vecuronium. Mechanical ventilation is applied during the blockage as muscular paralysis and apnoea are produced. However, as the extracocular muscles are very sensitive to the action of NMB’s, these tend to be paralysed easily and longer than the rest of the muscles, like the diaphragm and intercostal muscles involved in respiratory dynamics. For it is possible to keep the eye centred with small doses of NMB’s not to induce apnoea. In one study conducted with 16 dogs, a doses of rocuronium (0.1 mg/kg) was capable of causing central position of the globe with minimal interference on the most important ventilatory parameters. In any case, I prefer the use of conventional doses for rendering unexpected movements of the patient during surgery, ensuring adequate ventilation and avoid unexpected situations that often have a dramatic end.

**Smooth induction and recovery**

It is important to reduce stress and excitation signs for the induction of anaesthesia and prevent the cough at the time of intubation and ensure a smooth and painless recovery. Induction with mask is not recommended except in patients too sedated or too depressed, because it is not often quick or smooth. Intravenous induction, and always depending on the nature of the case, can be performed with thiopental, propofol, etodimate and alfaxan, with or without benzodiazepine as co-inductor. To prevent the cough reflex an adequate depth anaesthesia must be attained, or we can administer lidocaine or fentanyl at reduced doses as previously pointed prior to intubation.

**Pain control**

Pain control is essential in these patients because in many cases that is very intense. In most cases it is appropriate to apply the principles of pre-emptive multi-modal analgesia, unless the patient’s condition contraindicates it, i.e. a geriatric diabetic with renal problems is not an ideal candidate to receive NSAID’s. In general superficial corneal ulcers are usually more painful than the deep ones, and for these lesions the dolichocephalic breeds appear to be more susceptible to pain than brachiocephalic ones. In general, the superficial pain can be controlled with eye drops of local anaesthesia (proparacaine, tetracaine) which have a quick action but transitory. On the other hand, the pain form glaucoma or intraocular uveitis is better controlled with opioids such as morphine, methadone (does not induce vomiting) or buprenorphine (in cases of milder pain) and NSAID’s like carprofen or meloxicam (plus atropine to alleviate myosis). Looking to improve intraoperative anti-nociception the use of fentanyl results very convenient. In situations of chronic pain the intra-operative ketamine infusions or its administration at low dose bolus will help to control or even reverse central hyper-sensitization situations. It has been evaluated the efficacy of intraocular lidocaine 1-2% administration, as well as continuous infusion with benefits in the case of the latter technique, similar to morphine. In general, cataract surgery requires the establishment of an adequate mydriasis. It should then assess the risk of myosis derivative of morphine in dogs (not in cats) and its potential interferences with the mydriatic action of topical products such as atropine and tropicamide typically used in the preparation of the patient undergoing cataract surgery. In this scenario, many prefer, due to its greater reliability, the use of methadone and hydromorphone as reliable alternatives to morphine. Ketamine induced mydriasis is accused.

**Drug interactions**
- Corticosteroids can cause adrenal suppression, delay wound healing, immunosuppression and reduced tolerance to stress caused by surgery and anaesthesia.
- Carbonic anhydrase inhibitors cause metabolic acidosis and hypokalemia.
- Mannitol causes hypervolemia and hypertension if quickly administered or overdosed. If administered over several days can lead to dehydration. Best to avoid its use in renal and cardiac patients.
- Phenylephrine causes severe hypertension that can be corrected with low doses of acepromazine.
- Beta-blocker cause cardiovascular depression (bradycardia and hypotension) similar to that induced by general anaesthesia.

Tear production
In general there is a dose dependant decreased production of tears under sedation and general anaesthesia. The acepromazine, xylazine, medetomidine, diazepam, atropine, as well as various opioids are associated with this reduction. In particular, the combination of xylazine butorphanol have an important synergistic negative effect between both drugs. It is recommended to administer artificial tears every 60 minutes especially if using ketamine or NMB's.

Anaesthesia technique
After properly assessing the patient and stabilizing if required, i.e. Diabetes, the design of anaesthesia will depend on the patient's temperament, physical condition and nature of the procedure (extra or intraocular). In general, for pre-anaesthesia, methadone and acepromazine combination is a reasonable option in most routine cases. In nervous patients, the use of dexmedetomidine or medetomidine in small doses is desirable to provide a free stress management. For the induction, it is advisable the use of diazepam or midazolam (0.2-0.3 mg/kg) IV as co-inductor agent to accelerate the induction and reduce the required doses of thiopental, propofol, alfaxan, etc. as deemed more suitable for induction. In brachiocephalic breeds, susceptible to the development of corneal ulcers, is advised pre-oxygenate and perform and rapid induction to gain control of the air tract immediately. For these procedures, the use of orotracheal tube with a metal frame reduces the risk of accidental obstructions resulting from forced positions during surgery. At this stage it is essential to prevent or treat relatively common hypoventilation situations after induction.

Maintenance is usually carried out with isoflurane or sevofluorane combined with oxygen, through the most appropriated respiratory circuit. The circular type and the Bain are adequate if mechanical ventilation is established. It is important to prevent hypothermia and control glycemia levels in diabetic patients during surgery. For intraocular procedures NMB's will be administered and mechanical ventilation used. Towards the monitoring of these patients it is important to have EKG, non-invasive or invasive blood pressure (preferably catheterizing metatarsal artery), haemoglobin arterial saturation (using vulvar or preputial probes), capnography, temperature and if possible registering inhalational agents concentrations. The degree of neuromuscular blockage can be also monitored by a neuro-stimulator (usually using as pattern the stimulation of the "train-of-four") Not to interfere with surgery, it is recommended to stimulate the peroneal nerve.

Towards recovery, the reverse of NMB's will be assessed by the "train-of-four". For this, neostigmine and atropine or edrophonium will be administer. Sometimes, a single dose of the blocker can maintain the eye centred during the whole surgery, so if these blockers are not re-dose, the reversion will not always be necessary, particularly after lengthy procedures. The recovery should be smooth, quiet and free of pain. At extubation an excessive reflex that can lead to cough will be avoided. It is useful applying sedatives and analgesics in this phase, and to put buster collars to minimize the risk of self harming by the patient.

References: