Critically Appraised Topic

The retrobulbar block: A review of techniques used and reported complications

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Introduction

The ocular examination in horses with painful eyes is limited by their physicality and powerful orbicularis oculi muscles. Ocular examination is normally facilitated by a combination of chemical restraint (sedation), topical local anaesthesia and periocular nerve blocks. For the majority of horses, blocking the auriculopalpebral nerve (CN VII) to immobilise the orbicularis oculi muscle, and supraorbital nerve (frontal n., CN V – ophthalmic branch) to desensitise the upper eyelid, will facilitate ocular examination, collection of samples from the ocular surface and placement of subpalpebral lavage systems (Labelle and Clark-Price 2013).

The retrobulbar nerve block (RBNB) involves injecting local anaesthetic directly within the periorbita, (Fig 1), and in general practice, can be utilised for standing enucleations. In the referral setting, the RBNB is used in numerous procedures including standing corneal surgeries (keratectomies and grafting), eyelid surgeries, laser ablation of granula iridica cysts and cytophotocoagulation for management of glaucoma. The RBNB has the advantage of adding safety to a procedure by removing the requirement for general anaesthetic by facilitating standing procedures (Pollock et al. 2008), as well as impeding the cardiac changes of the oculocardiac reflex (OCR) (Raffe et al. 1986).

The periorbita is a conically-shaped fibrous membrane that encloses the ‘intracranial’ muscles, fats and blood vessels behind the eye. It extends from the globe obliquely to the apex of the orbit. Structures enclosed by the periorbita include the extraocular muscles and their motor nerve branches (CN III, IV and VI) and the optic nerve (CN II). Sensory nerves (including branches of the ophthalmic nerve (CN V), lacrimal n., supraorbital and infratrochlear n., and maxillary nerve (CN V; zygomatic n.)) which provide sensation to the eyelids and periocular skin, are not consistently blocked by the RBNB. The branches of the ophthalmic nerve which provide innervation to the eyeball (long and short ciliary nerves) are consistently blocked by the RBNB. As a result of this inconsistent anaesthesia of the sensory branches of CN V supplying the eyelids, additional nerve blocks are required for desensitisation of the eyelids,

Fig 1: Schematic of the retrobulbar structures. 1. Dorsal rectus muscle; 2. ventral rectus muscle; 3. retractor rubri muscle; 4. supraorbital foramen; 5. infratrochlear nerve; 6. orbital apex (including orbital foramen, orbital fissure and foramen rotundum); 7. ophthalmic nerve (CN V); 8. lacrimal nerve; 9. lacrimal gland; 10. optic nerve (CN II); 11. long ciliary nerves (branch of the nasociliary nerve, CN V1); 12. sensory root; 12. A) ciliary ganglion; 12. B) short ciliary nerve branches (innervating cornea, iris and ciliary muscles, not depicted); 13. zygomatic nerve; 14. maxillary nerve; 15. maxillary artery. Green dashed lines denote the periorbita, dorsally and ventrally.

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commonly the supraorbital nerve for the upper eyelid and a line block for the lower eyelid and canthi.

Complications of the retrobulbar block have been described as intra-meningeal injection from caudal placement of the needle, haematoma formation from placement of the needle too ventrally, globe trauma, optic neuritis and nerve penetration, prolapse of the globe secondary to extraocular muscle blockade, orbital cellulitis and abscessation, and orbital oedema (Gilger and Davidson, 2002; Tremaine 2007). Although a wide variety of complications are reported, with some being devastating, involving morbidity to the eye or mortality of the patient (Labelle and Clark-Price 2013), these are very dependent upon the technique utilised. For this reason, this review will consider the three commonly utilised techniques separately: the four-point block (RBNB-P/MP), Peterson or modified Peterson block (RBNB-P/SOF) and blockade via the supraorbital fossa (RBNB-SOF). This paper seeks to critically appraise the literature on recognised complications reported with the various types of RNB used in equine practice, according to the relevant literature identified.

Preparation for the retrobulbar block

Complications are recognised with the RNB: however, the practitioner can take a number of steps to limit these risks in their preparation.

1 Manual restraint. Manual restraint and head positioning are essential for comfort and stabilisation of the patient and good visualisation for the practitioner; many practitioners elect to use stocks, a head-stand or hay bales and an assistant who is experienced in horse handling.

2 Chemical restraint. This facilitates accurate and safe administration of the block. Often, the patient’s anxiety, ocular pain and movement require sedation, additional to the local anaesthesia (Labelle and Clark-Price 2013). Alpha-2 agonists are the most commonly used sedative for equine standing procedures (Labelle and Clark-Price 2013). Of this class, xylazine, detomidine and romifidine have been described in literature. Some authors cite detomidine HCl (0.01–0.02 mg/kg i.v.) as the best means of sedation for minimal head movement, and xylazine and an adjunct of butorphanol are the worst (Gilger and Davidson, 2002). However, butorphanol as an adjunct to an alpha-2 is widely used by other practitioners (Labelle and Clark-Price 2013), who acknowledge that there is an association with systemic opioid use and mizzle tremors and head movements (Robertson 2004), but that the benefits of anti-nociception out-weigh this potential effect. These tremors are often not seen at the doses administered for standing sedation (Townsend 2013). Detomidine CRI s are also described for longer procedure (Labelle and Clark-Price 2013).

3 Site preparation. Sterile site preparation can reduce the risk of bacterial inoculation from a needle, thereby reducing the risk of cellulitis and orbital abscesses (Gilger and Davidson, 2002). The area prepared will depend on the type of RNB being used. In the case of the RNB-SOF, it is necessary to clip and aseptically prepare the orbital fossa, above the dorsal bony rim of the orbit, and the zygomatic arch (Stoppini and Gilger, 2017). For the RNB-P and RNB-P/MP, the peri-orbita is surgically prepared (Hewes et al. 2007). Iodine should be used for aseptic preparation at a concentration of 1:50 (Roberts et al. 1986), as chlorhexidine or alcohol can cause corneal irritation and ulceration (Gilger and Davidson, 2002).

Literature review

Search strategy

Search terms “equine” OR “equid” OR “equids” OR “horse” OR “horses” OR “pony” OR “ponies” AND “eye” OR “eyes” OR “orbit” OR “orbital” OR “ophthalmic” OR “ophthalmology” AND “local anaesthesia” OR “local anesthesia” OR “local anaesthetic” OR “retrobulbar” OR “retrobulbar block”

An additional search using the specific complications of the retrobulbar block yielded no further results [Search terms “ocular penetration” OR “ocular perforation” OR “globe perforation” OR “ocular penetration” OR “globe penetration” OR “subarachnoid anaesthesia” OR “intra-meningeal anaesthesia” OR “subarachnoid anaesthesia” OR “intra-meningeal anaesthesia” OR “ocular penetration” OR “globe perforation” OR “ocular penetration” OR “globe penetration” OR “retrobulbar haemorrhage” OR “retrobulbar bleeding” OR “globe ischaemia” OR “eye ischaemia” OR “optic nerve atrophy” OR “optic nerve neuritis” OR “extra-ocular muscle damage” OR “optic nerve perforation” OR “optic nerve penetration”].

Quantity of evidence

Results were filtered by whether they discussed the use of the RNB in equids. This yielded seven relevant results looking at the clinical use of the retrobulbar block; one of these was a tutorial article (Tremaine 2007) and hence has been referenced but not included in the analysis of reported complications. Six articles, which are retrospective or prospective experimental studies, reporting on complications from the retrobulbar block itself, or associated complications from enucleations, were analysed. With the exclusion of one paper, Morath et al. 2013, due to concerns regarding the methodology, (The authors’ ex vivo study replicated the RNB-SOF under ultrasound guidance to the cone formed by the retractor bulbi muscle (RBM), which they equated with the intraconal space. The intraconal space is encompassed by the peri-orbita [Fig 1]. Injection into the space enclosed by the RBM which closely envelopes CN II would be associated with significantly higher risks such as damage to CN II, which was noted within this study with a case of CN II nerve sheath laceration,) five papers have been evaluated in this critically appraised topic.

Quality of evidence

Four papers were from peer-reviewed journals and one from the American Association of Equine Practitioners Proceedings, from a peer-reviewed convention. All papers found are of high reputation, providing a good quality of evidence. A summary table (Table 1) highlights different impact factors of these journals.

A larger sample size can affect confidence intervals in the data analysis, and validity of conclusions. The papers
in the summary of the RBNB-4P technique by Pollock et al. (2008), a prebent, 20-gauge, 9-cm needle is inserted at the 12, 3, 6, and 9-o’clock positions around the orbit, and the needle is advanced along the curve of the bony orbit until the most caudal aspect of the orbit is met. However, using the orbital rim as a guide is only possible dorsally and medially, as the orbit of the horse is open. Although the orbital rim is complete and ventrally and laterally, this may provide an initial guide, beyond the rim there is no bony orbital wall to follow; therefore needle passage through the soft tissue is not facilitated by any specific landmarks. This is of particular importance ventrally due to the proximity of the maxillary artery and nerve which lie just ventral to the periorbita. Of the techniques visited in this literature review, the RBNB-FOS technique described by Hewes et al. (2007) involves advancing the needle until it is approximately two-thirds of the way around the globe and as such avoids the risks associated with injecting in the region of the orbital apex; despite this, there is still no reliable way of establishing if the periorbita has been penetrated prior to injection of local anaesthetic.

The RBNB-MP/P technique utilises a long, curved needle, injected 1 cm lateral to the lateral canthus of the eye (Raffe et al. 1986), while Tremaine (2007) described a 8-cm needle over zygomatic arch, and then advanced in a ventromedial path. The injection point is defined as when the medial orbital bone is reached (Tremaine 2007); this is not specified by Raffe et al. (1986). From these descriptions, there are no reliable indicators to determine when the needle has reached an appropriate position with respect to the periorbita or orbital apex, and as such, it is impossible to be certain as to the exact location of the local anaesthetic injection.

In contrast, however, the RBNB-FOS needle placement is just caudal to the globe, thereby avoiding the risks associated with injections into the region of the orbital apex. Furthermore, the sigmoid flexure in the optic nerve in which it courses ventrolaterally before entering the globe leaves it less vulnerable to damage from a needle placed through the dorsal periorbita. The landmarks for needle placement are well defined and easily identified, and accurate needle positioning for anaesthetic injection can be identified by the initial dorsal globe movement (when the needle impinges in the periorbita), the tactile ‘pop’ as this fascial plane is penetrated, and the return of the globe to a central position once the periorbita is penetrated.

Discussion of complications

The published complications associated with all types of RBNBs are low:

- Raffe et al. (1986) 1/12 (RBNB-MP);
- Hewes et al. (2007) 0/5 (RBNB-4P);
- Pollock et al. (2008) 5/40 (RBNB-4P, RBNB-FOS 36/40 & RBNB-FOS 4/40);
- Oel et al. (2014) 0/5 (RBNB-FOS);
- Gilger and Davidson (2002) 2/189 (RBNB-FOS)

The greatest limitation on interpreting these data is that in most studies, the globes have been enucleated, and as such, there is no way of determining whether significant trauma to the neurovascular structures of the globe or orbit was damaged. In the study by Raffe et al. (1986), 50% of horses had procedures not involving enucleation, and in the papers of Hewes, Pollock and Oel, all eyes were enucleated.

Conclusions of the evidence

The evidence from each paper is summarised in Table 2.

Results discussion

Discussion of techniques

The RBNB for use in general practice should ideally be relatively straightforward to perform following a well-defined protocol, provide predictable anaesthesia to the globe and orbit, and have a low risk of complications. The ease with which a RBNB protocol can be performed relies on having well-defined and identifiable landmarks for needle placement and reliable indicators for when the needle has reached an appropriate position for anaesthetic injection. The latter will ensure that anaesthetic is delivered to a location which will block the sensory and motor nerves within the periorbita. Of the techniques visited in this literature review, the RBNB-SOF has the technique whereby accurate needle placement can most easily be identified and involves placement in a location with the fewest vulnerable structures.

The RBNB-4P and RBNB-MP/P techniques involve injection in the region of the orbital apex. This region consists of a high density of cranial nerves, arteries, veins and extraocular muscle insertions passing from the optic canal, orbital fissure and rostral alar foramen (Fig 1, ‘orbital apex’). Furthermore, just ventral to the periorbita lies the maxillary artery which is a direct branch of the internal carotid artery and associated maxillary nerve (CN V).

In summary, the RBNB-4P technique by Pollock et al. (2008), a prebent, 20-gauge, 9-cm needle is inserted at the 12, 3, 6 and 9-o’clock positions around the orbit, and the needle is advanced along the curve of the bony orbit until the most caudal aspect of the orbit is met. However, using the orbital rim as a guide is only possible dorsally and medially, as the orbit of the horse is open. Although the orbital rim is complete and ventrally and laterally, this may provide an initial guide, beyond the rim there is no bony orbital wall to follow; therefore needle passage through the soft tissue is not facilitated by any specific landmarks. This is of particular importance ventrally due to the proximity of the maxillary artery and nerve which lie just ventral to the orbit. 

Therefore, Hewes et al. (2007) provided the lowest quality of evidence with the smallest sample size and being from the journal with the highest impact factor. Conversely, Pollock et al. (2008) had the second largest sample size and was from the journal with the lowest impact factor. The highest impact factor was with the journal in which Pollock et al. (2007) had the lowest quality of evidence with the smallest sample size and being from the journal with the lowest impact factor. One must consider that the second largest sample size and was from the journal with the lowest impact factor. However, one must consider that the highest impact factor. However, one must consider that the highest impact factor. However, one must consider that the highest impact factor. However, one must consider that the highest impact factor. The journal with the lowest impact factor. Therefore, Hewes et al. (2007) provided the lowest quality of evidence with the smallest sample size and being from the journal with the highest impact factor. 

All papers were considered to be of acceptable quality to contribute to the conclusions of this literature review.

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Therefore, for these techniques we may have false negatives for ‘no complications’. By contrast, Gilger and Davidson were the largest study involving 189 horses (RBNB-FOS) of which 80–85% were procedures other than enucleation (personal communication). Therefore, we can have a higher confidence that this paper is reflective of the complication rates associated with this technique.

Only one case experienced a suspected post-operative infection (Pollock et al. 2008). The RBNB itself often does not merit use of antimicrobials; however, for enucleations, there is a risk of surgical site infection due to the indication itself for enucleation (corneal perforation, infected ulcers), potential implant placement, opening of the conjunctival sac, increased difficulty maintaining asepsis in a standing surgery.

### TABLE 2: Summary of retrobulbar block complications

| Reference and study type | Patient group | Theoretical complications described | Key results; complications experienced | Study weaknesses |
|--------------------------|---------------|--------------------------------------|---------------------------------------|-----------------|
| Raffe et al. 1986        | 12 enucleation cases with retrobulbar nerve blocks, and a control group of 25 enucleations without retrobulbar nerve blocks. | Optic neuritis, trauma to retrobulbar structures, stimulation of the oculocardiac reflex. | Bradycardia (4/25 of the control group, 1/12 of the retrobulbar group). No other complications described. | Small sample size. 6/12 nerve block cases were enucleated; unable to determine neurovascular damage to orbit/globe postsurgery, or if the eye was visual. The authors state that there was ‘no signs of tissue injury’, such as optic neuritis from gross evaluation, but does not exclude potential for neurovascular damage without histopathology. Unsure if bradycardia was due to traction or an incomplete block. |
| Gilger and Davidson 2002 | 189 retrobulbar blocks performed between 1996–2001: the author estimated 80–85% of these were for non-enucleation procedures (personal communication). | Orbital abscesses and cellulitis, trauma to the extraocular muscles, optic nerve, sclera and ophthalmic arteries. | 2/189 complications; one lidocaine hypersensitivity causing generalised hives and retrobulbar swelling, and one post-operative ulceration. No complications associated with block administration. | Small sample size. All retrobulbar nerve block cases enucleated so unable to determine neurovascular damage to orbit/globe postsurgery, unable to assess if eye was visual. All retrobulbar nerve block cases enucleated so unable to determine neurovascular damage to orbit/globe postsurgery, unable to assess if eye was visual. |
| Hewes et al. 2007        | Standing enucleation in 5 adult horses. | Not discussed. | Not discussed. | Minimal haemorrhage, no contralateral blindness. |
| Pollock et al. 2008      | Standing transpalpebral enucleation in 40 horses between 2003–2007. 36/40 with a four-point retrobulbar nerve block and 4/40 with a retrobulbar nerve block via the supraorbital fossa. | Vagal nerve stimulation causing cardiac dysrhythmias. | Complications referred to the surgery itself rather than the block; mild oedema around the surgical site (5), facial nerve paralysis (1) which resolved 3 h post-operatively, 1 serosanguinous discharge which was treated with 20 mg/kg metronidazole orally, twice daily. | Small sample size. All retrobulbar nerve block cases enucleated so unable to determine neurovascular damage to orbit/globe postsurgery, unable to assess if eye was visual. All retrobulbar nerve block cases enucleated so unable to determine neurovascular damage to orbit/globe postsurgery, unable to assess if eye was visual. |
| Oel et al. 2014          | 16 horses undergoing enucleation under inhalation anaesthesia only (10), or retrobulbar nerve block and inhalation anaesthesia (6). | Not discussed. | No complications of the block discussed. 1 transitory bradyarrhythmia which didn’t require treatment; 2 in the nonretrobulbar group, 1 of which required atropine. | Small sample size. All RBNB cases enucleated so unable to determine neurovascular damage to orbit/globe postsurgery, or if eye was visual. |
as opposed to in a theatre, the duration of the procedure itself and prolonged use of antimicrobials predisposing to resistant bacteria (Huppes et al. 2017). Therefore, there may be some bias towards a low-rate of infection following the RBNB, as practitioners elected to use antibiotics for the enucleation procedure.

All of the above studies were performed within a referral hospital environment. One must therefore bear in mind that the experience of the practitioner and their familiarity with the technique influences the rate of complication.

Other complications reported in equine practice (such as the aforementioned haematoma formation, intra-meningeal injection and trauma to the globe and/or optic nerve) were not reported in any study.

**Clinical message**

This article seeks to clarify whether clinicians should be concerned for the complications of a retrobulbar block in clinical practice. There are only a small number of reported studies on complications of the retrobulbar block in horses, but these indicated a low incidence of complications. The retrobulbar block can be utilised for standing ophthalmic procedures or to increase physiological stability within a general anaesthetic, with few reported complications. The practitioner must be aware that potential complications may be reported as low in incidence, however, they are of high morbidity, including vision loss, seizure or death of the patient. In all of these studies, the practitioners performing these blocks are in specialist institutions; the indications for the RBNB are predominantly for procedures within a referral institution, and therefore, the first-opinion practitioner must be cognisant that it has potential for a high risk of complications outside of this setting. With the exception of a standing enucleation, the first-opinion veterinarian may never need to use this block. As previously stated, the RBNB-SOF has the best defined and most easily identifiable indications of successfully reaching the desired site for injection and has a low reported complication incidence in nonenucleated eyes, which is a better indicator of true morbidity to the globe caused by a RBNB than in enucleated studies. Hence, it would be the author’s recommendation that experienced practitioners who are familiar with the procedure utilise this block for cases where local analgesia and sedation do not suffice.

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