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Surgery

Ultrasound-guided Auriculopalpebral and Retrobulbar Nerve Blocks in Donkeys

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ABSTRACT

This study aimed to evaluate the usefulness of ultrasound guidance for auriculopalpebral and retrobulbar nerve blocks in donkeys. Hence, this study was carried out in two phases: Phase 1 (cadaveric study); in which the heads of three donkey cadavers were used (one for preliminary anatomical investigation and two for evaluation of ultrasound-guided injection of 1ml of methylene blue 1% around each nerve) and phase 2 (live animal study); in which eight donkeys were randomly assigned for each of ultrasound-guided auriculopalpebral(using 1ml of lidocaine 2%) and retrobulbar nerve (using 6ml of lidocaine 2%) blocks on different eye sides of the same animal. In Phase 1, the landmarks for ultrasound-guided injection of auriculopalpebral and retrobulbar nerve blocks were determined. Staining of the proposed nerves with methylene blue under ultrasound guidance was also assessed. In phase 2, success and complications following nerve blocks were determined. Ear dropping and akinesia were recorded 5±0.5minutes after auriculopalpebral nerve block and lasted for 42±3 minutes. Exophthalmoses of the eyeball, mydriasis, immobility of the globe and corneal anesthesia were evident 6±1 minutes following retrobulbar nerve blocks and lasted for about 100±11 minutes. No complications were recorded following nerve blocks. On conclusion, ultrasound guidance could be useful tool for successful and safe auriculopalpebral and retrobulbar nerve blocks in donkeys.

Keywords: Donkey, Retrobulbar, Auriculopalpebral, Nerve block, and Ultrasound-guided.

INTRODUCTION

Ultrasound guided injection is considered one of the important facilities in human and veterinary medicine, especially in equines. It is currently used for treating joint diseases (Denoix, 2006; Carnicer et al., 2008; David et al., 2007) in addition to neck, pelvic and back disorders in horses (Denoix & Heitzmann, 2005). Although the use of ultrasound guided injection for nerve blocks is still limited in equine medicine (Denoix et al., 2020), it is extensively used in other animal species (Campoy et al., 2010; Echeverry et al., 2010 and Shilo et al., 2010;).

Ultrasound- guided nerve block is a modern advanced technique that provides the operator an image of the nerve and the associated blood vessels using color Doppler. Ultrasound-guided nerve block allows accurate needle direction and monitoring of the distribution of the local anesthetic solution in real-time view. This technique has also the advantages of rapid onset and decreased requirements of local anesthetics (Williams et al., 2003; Gray, 2006; Sites & Brull, 2006; Casati et al., 2007; Ali et al., 2019).

Auriculopalpebral and retrobulbar nerve blocks are of great clinical significance in equine practice. Auriculopalpebral nerve block is repeatedly used to facilitate ophthalmic examination, collection of specimens from the ocular surface and placement of subpalpebral lavage systems as it produces eyelid akinesia (Labelle & Clark-Price, 2013; Gilger, 2016; Diehl & Bowden, 2020). Retrobulbar nerve block is one of the major blocks in equines' eyes that frequently used for standing corneal surgery, standing enucleation and cytophotocoagulation for management of glaucoma as it leads to eye, eyelids and periocular area desensitization via blockade of optic, the branches of the ophthalmic nerve, abducens, oculomotor, trochlear and maxillary nerves (Pollock et al., 2008, Leigh et al., 2021; McKinney, 2021; Hermans etal., 2022). Besides, retrobulbar nerve blocks can impede the cardiac changes of the oculocardiac reflex (Raffe et al., 1986) and increase the safety of procedures by eliminating the need for general anesthetics and facilitating standing procedures (Pollock et al., 2008).

In equines, several blind techniques have been reported for auriculopalpebral and retrobulbar nerve blocks (Gilger & Davidson 2002; Michau, 2005; Brooks, 2006; Muir & Hubbell, 2008; Toth et al., 2008 and Labelle & Clark-Price, 2013). Blind retrobulbar nerve blocks can been complicated with eyeball needle penetration, hemorrhage, optic nerve trauma, orbital abscess, intravascular or intrathecal injection which in turns can induce brainstem anesthesia, cardiac arrest, seizures, and sudden death (Robertson 2004; Labelle & Clark-Price, 2013; Oliver & Bradbrook, 2013 and Tranquilli et al., 2013).

To increase the accuracy and decrease the complications following retrobulbar nerve blocks, some studies have previously assessed ultrasound-guided techniques in horse cadavers as an alternative to blind ones (Morath et al., 2013; Hermans et al., 2022; Thieme et al., 2023).One study has also addressed this point in donkey cadavers (Hagag and El Nahas, 2022).

To authors' knowledge, ultrasound guidance for auriculopalpebral and retrobulbar nerve blocks in live donkeys has been yet investigated. Further, limited or no data is available about ultrasound-guided retrobulbar and auriculopalpebral nerve blocks, respectively in donkey cadavers. Consequently, this study aimed to evaluate the usefulness of ultrasound guidance for auriculopalpebral and retrobulbar nerve blocks in donkeys (cadavers and live animals).

MATERIALS AND METHODS

1.1. Animals

This study was a biphasic study whereas one phase was carried out on fresh heads from three donkey cadavers euthanized for reasons unrelated to study and free from head pathological conditions and any signs of ophthalmic diseases. The other phase of the study was carried out on eight adult healthy native breed donkeys (5 females and 3 males) aged 2- 4 years and weighting 150-200 kg. Animals were considered healthy based on complete physical examination, complete blood picture and serum biochemical analysis. Throughout the study, animals were housed in stalls at Surgery, Anesthesiology and Radiology department, Faculty of Veterinary Medicine, University of Sadat city. Donkeys were fed on proper diet and had a free access to water while being in their stalls. This study was approved by the institutional animal care and use committee (IACUC) of Faculty of Veterinary Medicine-University of Sadat City (Protocol no: VUSC-040-1-20).

1.2. Study design and assessments:

This prospective, experimental study was conducted in two phases:

1-Phase 1 (cadaveric study)

This phase was carried out on fresh heads from three donkey cadavers (3 heads in total). In the first part of this study (anatomical part), one head was dissected to detect and describe the landmarks for ultrasound-guided injection of auriculopalpebral and retrobulbar nerve blocks. For auriculopalpebral nerve, the skin was incised longitudinally between the ear and the highest point of the zygomatic arch, skin was reflected with the underlying fascia and dissection was continued carefully underneath to expose the nerve with its branches.

For retrobulbar nerve blocks, eye was dissected from the orbital fossa after closure of upper and lower eye lid together. Skin opening and dissection were from the end of each lid. After eye dissection, landmarks were detected.

In the second part of the cadaveric study, in the two remaining heads of donkey cadavers, 1ml of methylene blue 1% was injected under ultrasound guidance targeting the proposed nerves for assessment of stain distribution across these nerves (to evaluate the success of ultrasound-guided injection). The ultrasonographic shape of the proposed nerves and their related structures were also determined. An ultrasound system (EsaoteMyLab™One VET, Italy) equipped with multifrequency microconvex transducer (8-10 MHz) was used. Just prior to scanning, hair was clipped at supraorbital fossa and caudal to highest point of zygomatic arch and ultrasound coupling gel was applied for ultrasonographic imaging of auriculopalpebral nerve and orbital components. In case of auriculopalpebral nerve injection, probe was applied caudal to the level of the highest point of the zygomatic arch and rostral to the base of the ear and 24-gauge needle was applied subcutaneously cranial and /or caudal to the probe and 1ml of methylene blue 1% was injected.In case of intraconal retrobulbar injection, probe was applied transpalpebral on the closed upper eye lid and 21-gauge spinal needle was inserted perpendicular to supraorbital fossa to pass through extraocular muscle and retractor bulbi muscle to the orbital cone that surround optic nerve. For both nerves, 30 minutes following injection of methylene blue, nerves were dissected to determine the extent of stain distribution.

2-Phase 2 (live animal study)

In this phase, ultrasound-guided auriculopalpebral and retrobulbar nerve blocks were evaluated in eight donkeys. The studied animals were sedated with xylazine (Xyla Ject 20mg/ml, ADWIA. Cairo, Egypt) given intravenously a dose of 0.5mg/kg. Animals were also controlled with a twitch placed on the upper lip. In standing position, hair was clipped, and alcohol was applied at area of injection. After placement of ultrasound coupling gel, blocking of auriculopalpebral and retrobulbar nerves was done using the real time image produced by ultrasound machine (EsaoteMyLab™One VET, Italy) equipped with multifrequency microconvex transducer (8-10 MHz)) and color Doppler to avoid nerve and vascular injury. To block auriculopalpebral and retrobulbar nerves,1 ml and 6ml of lidocaine 2% (Debocaine20mg/ml, Al-Debeiky Pharmaceutical Industries Co., Egypt) were used, respectively (Muir & Hubbell, 2008; Labelle & Clark-Price, 2013). For lidocaine injection, placement of the probe and needle direction was carried out in similar way to that described for methylene blue injection (phase 1). In case of auriculopalpebral nerve, akinesia (no blinking) and ear dropping was considered as indicators of successful blockade of auriculopalpebral nerve. Mydriasis, immobility of the globe, exophthalmoses of the eyeball and corneal anesthesia were considered as indicators for blockade retrobulbar nerves. For both nerves, onset, and duration of block as well as skin nerve depth were recorded. All donkeys were followed up for 3 days after nerve blockade for detection of any complications.

1.3. __Statistical analysis:__

Graph Pad Prism software (version 5.0; San Diego, California) was used for calculation of mean ± S.D of the values of skin nerve depth, onset, and duration of anesthesia of each nerve.

RESULTS

Upon dissection of the cadaveric head, under skin and superficial fascia, auriculopalpebral nerve was allocated on both sides of the head, just caudal to the highest point of zygomatic arch. Dissection also revealed the two main branches of the auriculopalpebral nerve: auricular and palpebral branches. Auricular branch was identified by its caudal direction towards the base of the ear while palpebral branch (gives of smaller branches) was running rostrally towards eye (Fig.1).

With dissection for retrobulbar nerves, within the orbital cavity, eyeball was surrounded and supported by extraocular muscles and retractor bulbi muscle that was surrounding the optic nerve (Fig.2).

Following methylene blue injection under ultrasound guidance, dissection of the cadaveric heads has shown complete staining of the auriculopalpebral nerve and its related structures in all heads and there were no missing injection shots. Also, following retrobulbar injection of methylene blue, extraocular muscles, optic nerve and orbital fissure have been successfully stained. No injection shots were recorded in the globe or outside retrobulbar space (Fig.7).

The ultrasonographic characteristics of auriculo-palpebral nerve was evident by scanning the area just caudal to the highest point of the zygomatic arch. Ultrasonographically, directly underneath skin and superficial facia, auriculo-palpebral nerve was imaged as leaf like echogenic structure with mottled center (contains hyperechoic round dots dispersed in hypoechoic background) and hyperechoic wall. Auriculo-palpebral nerve was imaged directly caudal to hyperechoic curved like structure which representedthe highest point of zygomatic bone and close tothe superficial temporal vein which evident as anechoic round structure with hyperechoic wall (Fig.3). Auriculo-palpebral nerve was best imaged at a frequency of 10 Mhz and at depth of 1-3 cm on medial and lateral aspects of the head.

During scanning of retrobulbar space, an approporiate image was obtained at a frequency of 8Mhz and a depth of 8-10 cm at medial and lateral aspects of the head.For scanning, the transducer was placed on the closed upper eye lid. Ultrasonographically, the optic nerve appeared in contact with the caudal end of the globe, it appeared as triangular echogenic structure outlined by hyperechoic lines presented nerve sheath. Dorsal and ventral to the optic nerve, extraocular muscles and fats were imaged as multiple hyperechoic and hypoechoic layers (Fig.4).

To anesthetize auriculopalpebral nerve, 24-gauge needle seemed to be appropriate for lidocaine injection. Under real time imaging of ultrasound, the needle appeared as a hyperechoic tubular structure directed towards the nerve. Injected lidocaine solution was evident as anechoic portion (Fig.5). In the studied animals, the skin nerve depth for auriculopalpebral nerve was about 4.096± 0.64mm. Following lidocaine injection, ear dropping, and akinesia (absence of blinking) were demonstrated in the studied animals (8/8 of donkeys) 5±0.5 minutes after injection and lasted for 42±3 minutes.

For retrobulbar nerve blocks, 21x3.5-gauge spinal needle was suitable for deposition of lidocaine solution in retrobulbar space. Ultrasonographically, injection needle was evident as hyperechoic tubular structure directed towards the center of conal space while the injected lidocaine solution was imaged as anechoic portion (Fig.6). Using ultrasound image, the skin nerve depth for optic nerve from the closed upper lid was about 3.86± 0.26 cm. In the studied animals (8/8 of donkeys), mydriasis, immobility of the globe, exophthalmoses and corneal anesthesia were recorded 6±1 minutes after retrobulbar injection of lidocaine and lasted for 100±11 minutes.

No complications were reported in any of the studied animals over 3 days following auriculopalpebral and retrobulbar nerve blocks.

Figure 1: Head dissection of donkey cadaver showing auriculopalpebral nerve (1); auricular branch of auriculopalpebral nerve (2); palpebral branch of auriculopalpebral nerve (3); ear (4);curvature of the highest point of zygomatic arch (yellow line).

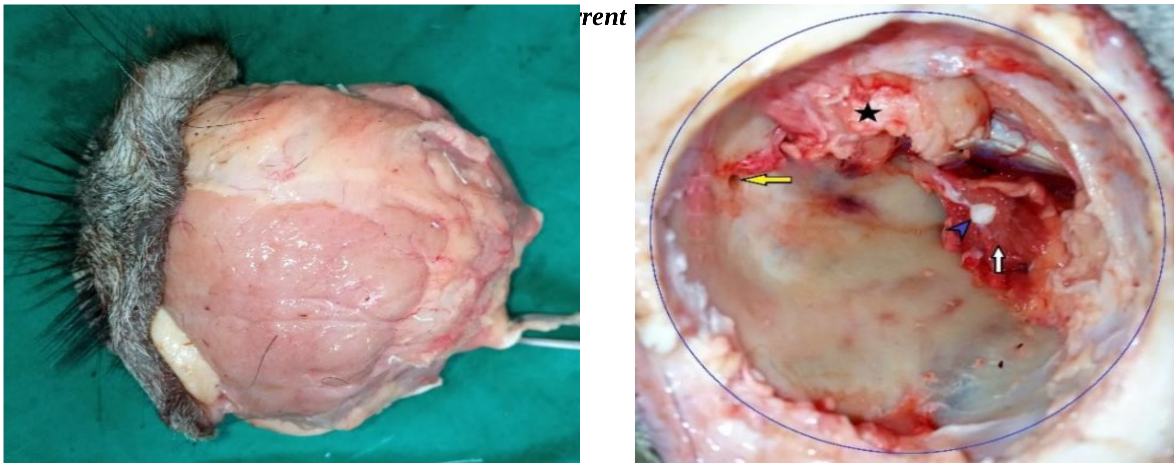

Figure 2: Head dissection of donkey cadaver showing optic nerve (blue pointed arrow); extraocular muscles (white arrow); periorbital fat from supraorbital fossa (black star); supraorbital foramen (yellow arrow); orbital fossa (blue circle).

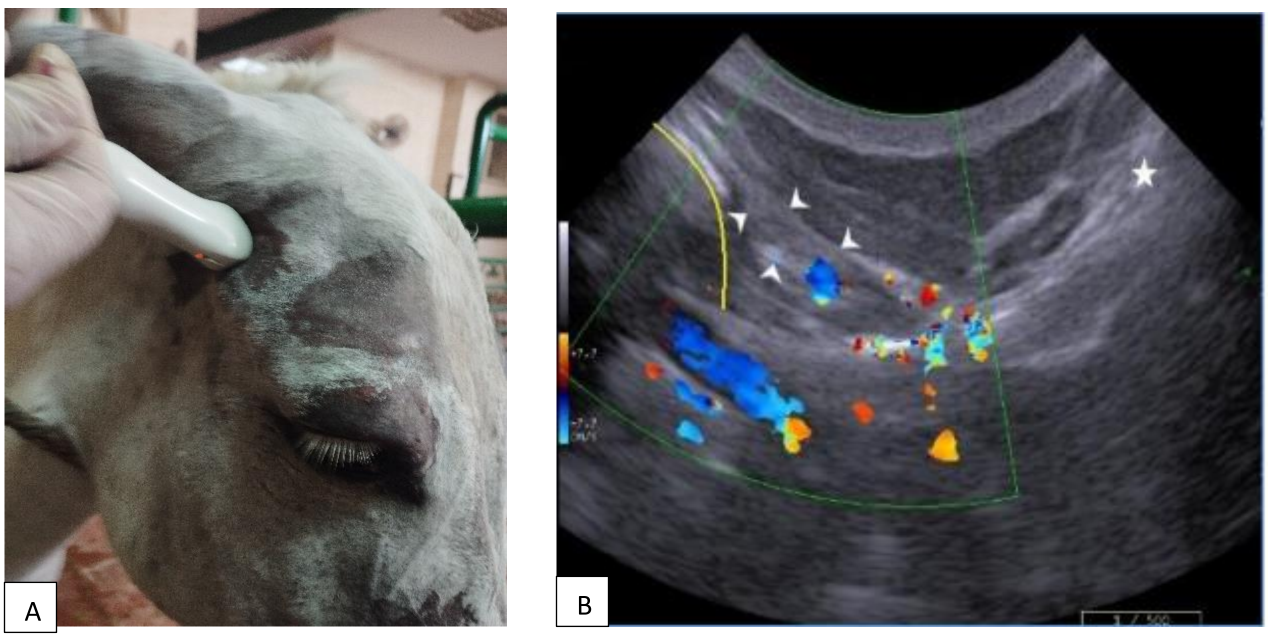

Figure 3: Ultrasonography of auriculopalpebral nerve: (A) probe orientation; (B) sonogram of auriculopalpebral nerve and related structures showing auriculopalpebral nerve (arrowhead); zygomatic bone (yellow curved line); temporal vein (round blue color signal); parotid salivary gland at the base of the ear (star).

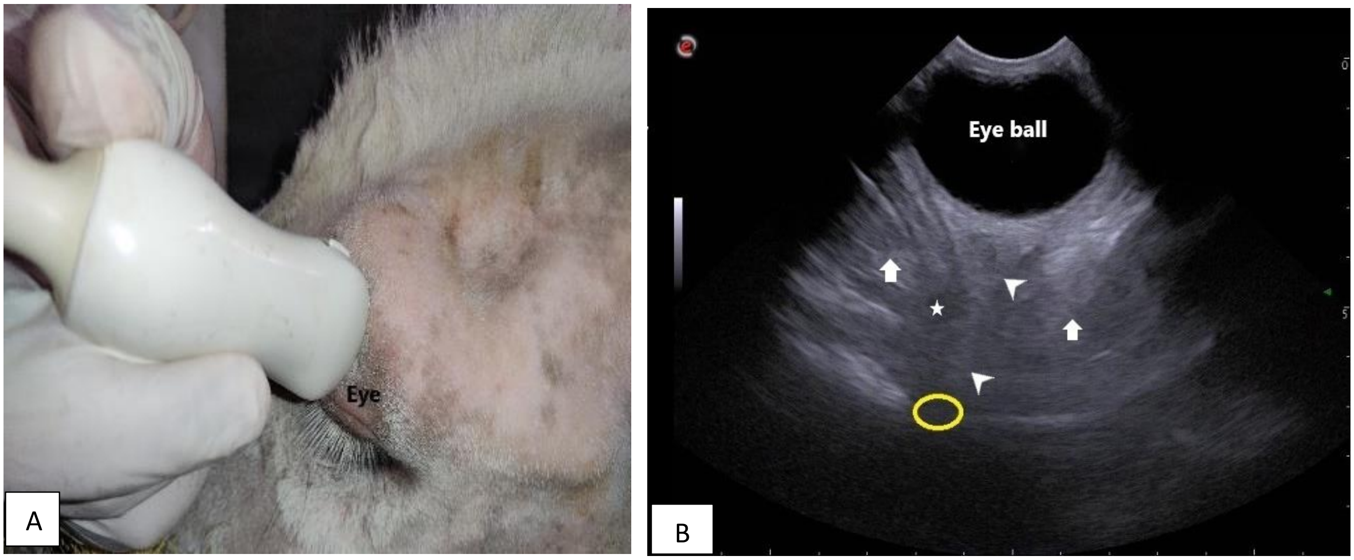

Figure 4: Ultrasonography of optic nerve: (A) probe orientation; (B) sonogram of optic nerve and related structures showing optic nerve (arrow head); extraocular muscles and fat (arrow); retrobulbar space (star); caudal bony surface of the eye and orbital fissure (yellow circle).

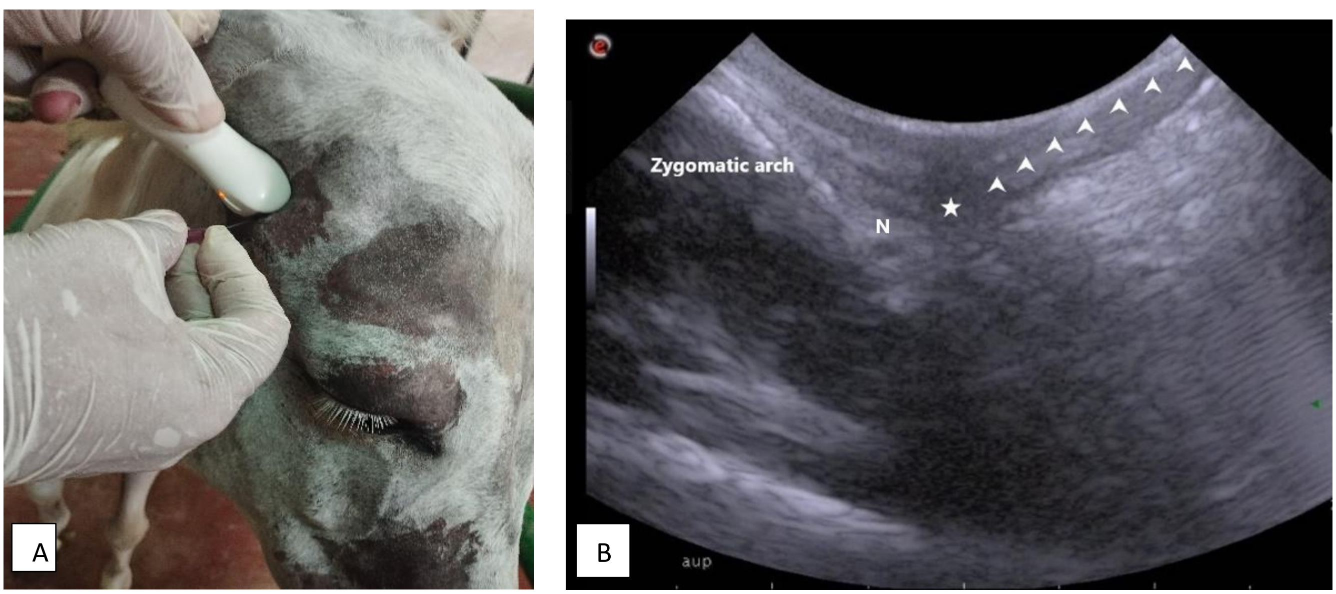

Figure 5: Ultrasound guided- auriculopalpebral nerve block: (A) probe and needle placement; (B) sonogram of ultrasound-guided technique showing auriculopalpebral nerve (N); injected fluid (star); needle (arrow heads).

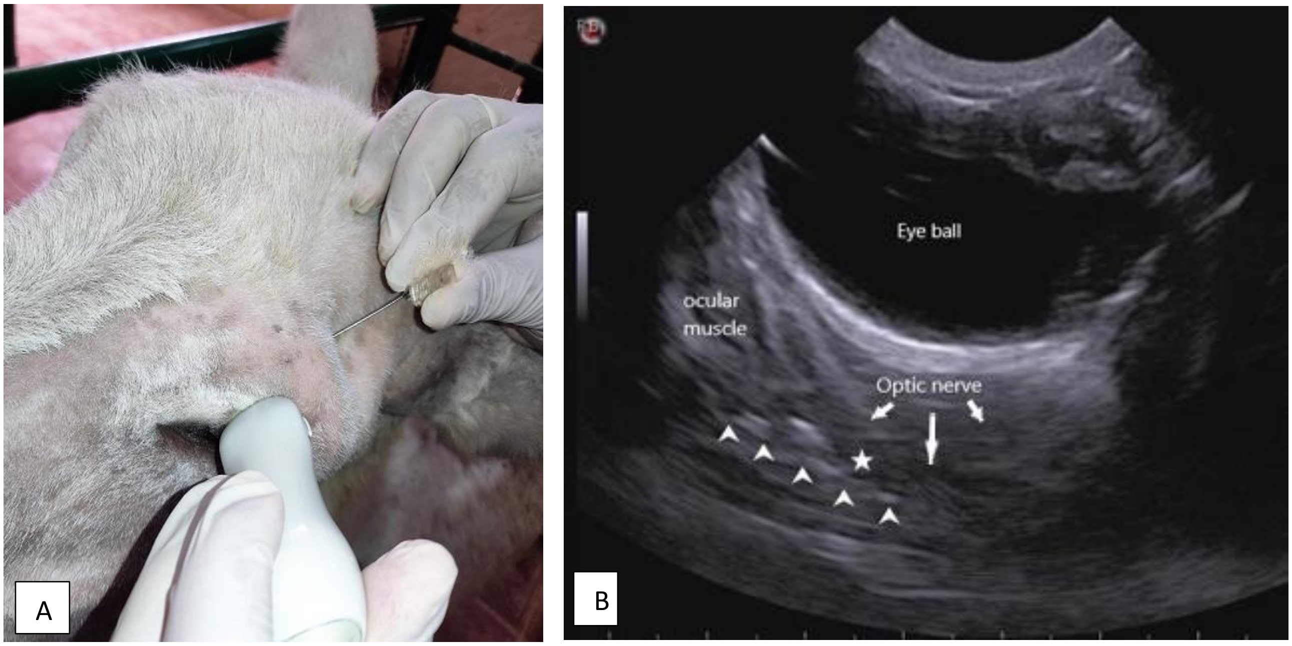

Figure 6: Ultrasound guided- retrobulbar nerve blocks: (A) probe and needle placement; (B) sonogram of ultrasound-guided technique showing retrobulbar space (star); optic nerve (arrows); needle (arrow heads).

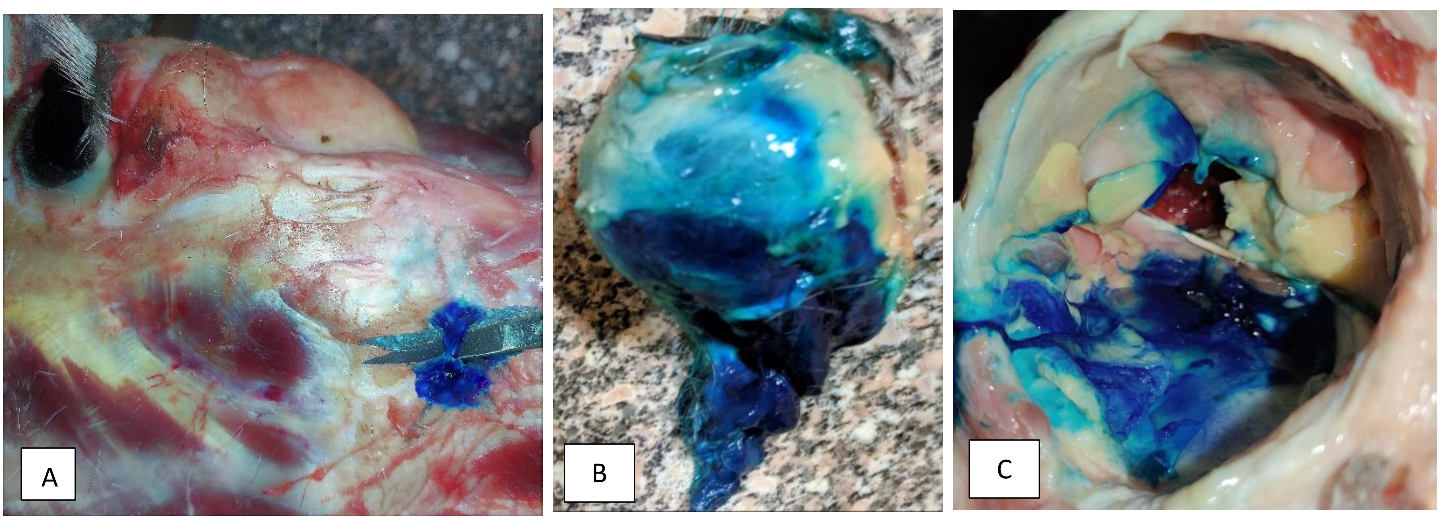

Figure 7: Stained nerves after ultrasound-guided methylene blue injection: (A) Auriculopalbebral nerve, (B, c) eye and orbital cone staining following retrobulbar space injection

DISCUSSION

In the study reported here, evaluation of ultrasound-guided auriculopalpebral and retrobulbar nerve blocks in live donkeys have been preceded by anatomical study (the first part of the cadaveric study) on the head of donkey cadavers. This was found successful in identifying the landmarks for ultrasound-guided nerve blocks together with understanding ultrasound findings.

For anatomical study, the cadaveric head was immediately used after being decapitated at the atlanto- occipital joint to avoid any cadaveric changes (Hagag &

Tawfiek, 2018). The results of anatomical study revealed that auriculopalpebral nerve was located caudal to the zygomatic arch. Similar findings were previously reported in donkeys (Maher et al., 2020).

In the present study, for ultrasonography of auriculopalpebral and retrobulbar nerves, a micro-convex transducer was used. This transducer was selected as it allowed excellent skin probe contact despite of head curvatures present at nerve sites.

During ultrasonography of auriculopalpebral nerve, good quality image was obtained at a frequency of 10Mhz and a depth of 1-3 cm. Consistently, previous studies (Alexander & Dobson, 2003; Helen et al., 2015), have recommended high frequency and low depth settings during scanning of superficial nerves to obtain a detailed ultrasound image.

In the present study, auriculopalpebral nerve was imaged as leaf like echogenic structure with mottled center (contains hyperechoic round dots dispersed in hypoechoic background) and hyperechoic wall. Similar ultsonographic apperance was reported in horses (Alexander & Dobson, 2003).

Methylene blue stain is repeatedly used for assessment of the success of ultrasound-guided nerve blocks in both horses and donkeys (Alexander & Dobson, 2003; Hagag & Tawfiek, 2018). Consequently, in the study reported here, staining of the proposed nerves with methylene blue was used as an indicator for successful ultrasound-guided injections.

In equines, failure or poor blockade of auriculopalpebral nerve has been reported following blind blocking techniques. One of the major causes for this was inaccurate needle placement (Diehl & Bowden, 2020). On these bases, in the current study, ultrasound was used to provide needle and nerve visualization in a real time manner as a trial to avoid inaccurate needle placement and to increase the success rate of auriculopalpebral nerve block.

Blind versus ultrasound-guided retrobulbar nerve blocks were previously compared in equine cadavers. Ultrasound-guided blocks were found to be safer (decrease the risk of complications) and more accurate compared to blind ones (Hermans et al., 2022; Thieme et al., 2023). The accuracy of ultrasound-guided retrobulbar nerve blocks was also demonstrated in donkey cadavers (Hagag & El Nahas, 2022). In agreement with these findings, in the present study, ultrasound guidance has allowed accurate and safe retrobulbar injections in both cadavers and live donkeys.

In live animal study, successful auriculopalpebral and retrobulbar nerve blocks (considering akinesia and eardrop following auriculopalpebral and mydriasis, immobility of the globe, exophthalmoses and corneal anesthesia following retrobulbar) were recorded in all studied donkeys. Under ultrasound guidance, these successful blocks were achieved by using 1 (for auriculopalpebral nerve) and 6 ml (for retrobulbar nerves) of lidocaine 2%.On contrary, for blind block of auriculopalpebral and retrobulbar nerves, twice lidocaine doses used in the present study were necessary (Gilger & Davidson, 2002; Labelle & Clark-Price, 2013; Townsend, 2013; Stoppini & Gilger, 2017; Yang et al., 2022). In consistent with our findings, for nerve blocks, lower doses of local anesthetics have been required with ultrasound–guided techniques versus the blind ones (Marhofer et al., 2010; Hagag & El Nahas, 2022 and Hermanset al., 2022).

CONCLUSION

Ultrasound-guided injection of methylene blue has successfully stained auriculopalpebral nerve and intraconal contents (optic nerve and extraocular muscles) in donkey cadavers. Also, in live donkeys, auriculopalpebral and retrobulbar nerve blocks have been successfully achieved (within reasonable time and for considerable duration) following lidocaine injection under ultrasound guidance. No complications were recorded in any of the studied animals following ultrasound-guided nerve blocks. On these bases, ultrasound guidance could be useful tool for successful and safe auriculopalpebral and retrobulbar nerve blocks in donkeys. This would be of great significance during diagnostic and standing ocular surgeries in donkeys.

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