Sub-Tenon's anesthesia in equine cataract surgery and vitrectomy: a retrospective case series (2018–2022)

O. Kiesse[1], P. Torgerson[2], S. A. Pot[3] , S. Stadler[4]

[1]Interlakes Pferdemedizin, Holzhäusern, Switzerland; [2]Section of Epidemiology, Vetsuisse Faculty, University of Zurich, Switzerland; [3]Ophthalmology Section, Vetsuisse Faculty, University of Zurich, Switzerland; [4]Pferdeklinik Tillysburg, Sankt Florin, Austria

Sub-Tenon-Anästhesie in der Kataraktchirurgie und Vitrektomie bei Pferden: Eine retrospektive Fallserie (2018–2022)

Der Zweck dieser Studie war es, den klinischen Einsatz von Sub-Tenon-Blöcken für chirurgische Eingriffe unter Vollnarkose am Augapfel von Pferden zu untersuchen. Eine retrospektive Datenanalyse wurde an 17 Augen von 13 Pferden zwischen 2018 und 2022 durchgeführt. Die Pferde wurden unter Vollnarkose und einer Sub-Tenon-Injektion einer Phakoemulsifikation oder Pars-plana-Vitrektomie unterzogen. Alle Eingriffe wurden vom gleichen Veterinär-Ophthalmologen durchgeführt. Bei sieben Augen wurde eine Sub-Tenon-Anästhesie in einer Dosierung von 7 ml Lidocain (Xylocain, 2 % Lidocainhydrochlorid, Deutschland, Aspen Germany GmbH) und an zehn Augen von 7 ml Mepivacain (Mepinaest purum 2 %, Mepivacainhydrochlorid, Schweiz, Gebro Pharma GmbH) appliziert. Die statistische Analyse verglich Wirkungseintritt und Dauer der Augapfelzentralisation sowie die Pupillenmydriasis zwischen den beiden Gruppen. Intraoperative und postoperative Komplikationen wurden ebenfalls bewertet.

Mepivacain zeigte einen signifikant späteren Wirkungseintritt in Bezug auf Augapfelzentrierung und Mydriasis (8,9 Minuten gegenüber 6 Minuten), aber auch eine signifikant längere Dauer der Augapfelzentrierung als Lidocain (31,5 Minuten gegenüber 15,6 Minuten). Zwischen den zwei Sub-Tenon-Block-Lösungen wurde kein Unterschied in der Dauer der Pupillenerweiterung (40,4 Minuten für 2 % Lidocain gegenüber 69,2 Minuten für 2 % Mepivacain) festgestellt. Chemosis trat in allen 17 Augen auf. Zu den chirurgischen Komplikationen zählten Hornhautepitheldefekte (5), Netzhautablösung (5), Linsentrübung (5), vorübergehende Blindheit während der Genesung (3) und Glaukom (2).

Die Sub-Tenon-Anästhesie ist eine praktikable Alternative zur systemischen neuromuskulären Blockade und zur retrobulbären Blockadenanästhesie für chirurgische Eingriffe am Augapfel von Pferden. Eine kontrollierte prospekti-

Abstract

A retrospective data analysis was performed on 17 eyes from 13 horses which underwent a sub-Tenon's injection to facilitate phacoemulsification or pars plana vitrectomy under general anesthesia between 2018 and 2022. All procedures were performed by the same veterinary ophthalmologist. Seven eyes received a sub-Tenon's dose of 7 ml lidocaine (XylocainÒ, 2 % lidocaine hydrochloride, Germany, Aspen Germany GmbH), and 10 eyes received 7 ml mepivacaine (MepinaestÒ purum 2 %, mepivacaine hydrochloride, Switzerland, Gebro Pharma GmbH). Statistical analysis compared onset and duration of globe centralization and pupil mydriasis between the two groups. Intraoperative and postoperative complications were also assessed.

Mepivacaine had a significantly later onset of action regarding globe centration and mydriasis (8,9 minutes vs. 6 minutes), but also a significantly longer duration of globe centration than lidocaine (31,5 minutes vs. 15,6 minutes). There were no statistically relevant differences between solutions regarding duration of pupil dilation (40,4 minutes for 2 % lidocaine vs. 69,2 minutes for 2 % mepivacaine). Chemosis occurred in all 17 eyes. Surgical complications included corneal epithelial defects (5), retinal detachment (5), lens opacification (5), temporary blindness during recovery (3) and glaucoma (2).

Sub-Tenon's anesthesia is a feasible alternative to systemic neuromuscular blockade and retrobulbar block anesthesia for surgical procedures on the equine globe. A controlled prospective in vivo study is needed to further evaluate effects and risks.

Keywords: sub-Tenon's, horse, local anesthetic, lidocaine, mepivacaine, ophthalmic surgery

https://doi.org/10.17236/sat00435

Eingereicht: 10.02.2024
Angenommen: 22.08.2024

Sub-Tenon's Anesthesia in Equine Cataract Surgery and Vitrectomy: A Retrospective Case Series (2018–2022)

O. Kiesse, P. Torgerson, S. A. Pot, S.Stadler

ve In-vivo-Studie ist erforderlich, um Wirkungen und Risiken weiter zu bewerten.

Schlüsselwörter: Sub-Tenon, Pferd, Lokalanästhetikum, Lidocain, Mepivacain, Augenchirurgie

Introduction

The successful outcome of surgical procedures like phacoemulsification and pars plana vitrectomy in horses depends on optimizing the intraoperative setup, including surgical exposure of the globe and lens, and reducing extraocular muscle tension to avoid vitreal expansion.[5,8,10,12,26]

Sub-Tenon's anesthesia (STA) is a regional anesthetic technique which produces extraocular muscle akinesia, pupil dilation and regional globe anesthesia through its localized effect on sensory nerves and muscles.[2,9] The globe is surrounded by the Tenon's capsule as its fascial sheath. Tenon's capsule fuses anteriorly with the conjunctiva close to the limbus and merges with the optic nerve and the surrounding meninges as well as the sclera at the optic nerve exit posteriorly. Short posterior ciliary arteries and posterior ciliary nerves pass the sub-Tenon's space. Draining vortex veins of the choroidal circulation traverse the sub-Tenon's space and the tendons of the extraocular muscles pass through to insert on the globe. Therefore, local anesthetic agents in the sub-Tenon's space will provide the globe with good analgesia (blocking ciliary nerves) and akinesia (spreading along the extraocular muscle sheaths, diffusing into the intraconal space, and reaching the eyelids).[9,21,25]

STA has been demonstrated to be very safe and is described to be a technically straightforward procedure to master in humans and dogs.[13,16,18,19] It has therefore seen an immense increase in popularity in human medicine during the last decades.[9,22,23] It has gained more scientific attention in dogs, cats and horses and is therefore a real alternative to the use of systemic neuromuscular blocking agents (NMB) or retrobulbar block anesthesia.[1–4,6,24,25]

Based on an equine cadaver study in 2017 by Stadler et. al.,[25] volumes of 7 to 10 ml of anesthetic solution were suggested to be appropriate for STA in horses. These volumes reached the anterior and posterior sub-Tenon's space as well as the extraocular muscle sheaths. Lower injection volumes failed to reach the posterior sub-Tenon's space, whereas higher volumes caused severe subconjunctival reflux of injection fluid.[25]

There are no clinical studies on the effect of STA for intraocular surgical procedures in horses to the authors knowledge. The aim of this retrospective case series was to describe the feasibility and the reliability of STA in a clinical setting for intraocular equine ophthalmic surgery under general anesthesia.

Materials and Methods

Study Design

Equine patients were examined ophthalmologically and operated by a board-certified veterinary ophthalmologist at three different veterinary hospitals. Records of horses that underwent phacoemulsification or pars plana vitrectomy surgery under general anesthesia with an STA performed between 2018 and 2022 were retrospectively reviewed. Horses that underwent surgery all underwent a short physical exam to evaluate their systemic health status. Mucosal membranes, mandibular lymph nodes, nasal discharge, jugular veins, cardiac and pulmonary auscultation as well as intestinal motility and body temperature were evaluated. Data on signalment, ophthalmic preoperative status (lesions related to equine recurrent uveitis (ERU) or cataract development), affected eye (right: OD, left: OS) type of surgery and local anesthetic agent, time until maximal mydriasis and centralization and their duration as well as intra- and postoperative complications were recorded. Informed owner consent was obtained for each case.

Clinical Procedures

Ophthalmic Examination

All eyes were examined by the same board-certified veterinary ophthalmologist before surgery. The examination included slit lamp biomicroscopy (Kowa SL-10, Kowa USA), corneal fluorescein staining (FLUOSTRIPS, Aivimed GmbH, Germany) and IOP measurement with rebound tonometry (iCareÒ Tonovet, icare, Vantaa, Finland). For the first ophthalmic exam patients were sedated with detomidine 0,01 mg/kg IV (EquisedanÒ, 10 mg/ml Detomidini hydrochloricum, Graeub, Switzerland,) and butorphanol 0,01 – 0,02 mg/kg IV (MorphasolÒ-10, Butorphanolum 10 mg/mg, Graeub, Switzerland), an auricopalpebralis block was performed.

General Anesthetic Technique

The anesthetic protocol for equine patients at the hospital 1 was as follows: The horses were premedicated with acepromazine 0,15 mg/kg IM (Vanastress 10 mg/ml, Vana GmbH, Austria) and xylazine IV (Sedaxylan®, 20 mg/ml, Dechra, Austria), induced with ketamine IV 2 mg/kg (Ketaset®, 100 mg/ml, Zoetis, Kalamazoo, MI, USA or Ketamidor®, 100 mg/ml, RichterPharma, Austria) and midazolam IV 0,06 mg/kg (Dormazolam®, 5 mg/ml, Dechra, Austria)

and maintained under general anesthesia using isoflurane (Isothesia™, Henry Schein, Melville, New York, USA) in oxygen at a concentration of 2,0 % – 3,0 %, as well as ketamine IV (20 ml, Ketamidor® 100 mg/ml RichterPharma, Austria,), xylazine (24 ml, 20 mg/ml Sedaxylan®, Dechra, Austria) and midazolam (6 ml, 5 mg/ml Dormazolam®, Dechra, Austria) in 1000 ml saline 0,9 % as IV infusion-drip (with an infusion rate up to 2 ml/kg/h).

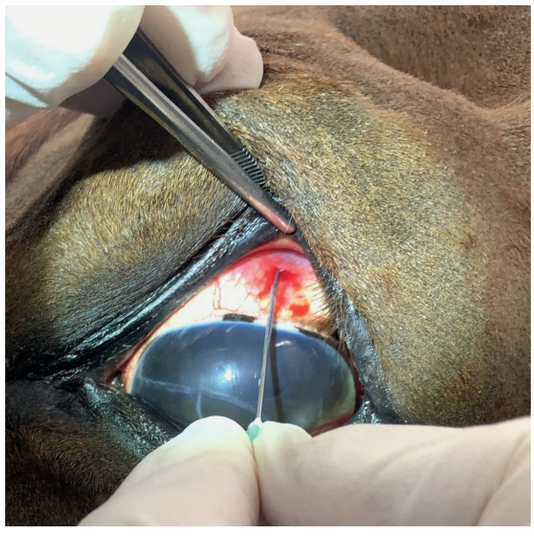
The anesthetic protocol for equine patients at equine clinic 2 and 3 was as follows. Premedication with 0,15 mg/kg acepromazine IM (Prequillan®, 10 mg Acepromazinum, arovet AG, Switzerland,) and 0,007 mg/kg medetomidine IV (DorbeneÒ, Medetomidini hydrochloridum, Graeub, Switzerland) was followed by induction with 2 mg/kg ketamine IV(KetasolÒ, Ketamini hydrochlridum, Graeub, Switzerland) and 5 mg diazepam IV (Valium®, Diazepanum 10 mg, Atnahs Pharma Switzerland AG, Switzerland) and maintenance on an inhalational anesthetic circuit with isoflurane (dosed to effect, Isoflurane; Attane™, Isoflurane, Provet AG, Switzerland) in 100 % oxygen as well as 0,0035 mg/kg/h medetomidine IV (DorbeneÒ, Medetomidini hydrochloridum, Graeub, Switzerland) and 0,06–0,3 mg/kg/h dobutamine IV (DobutrexÒ, Dobutamin, Teva Pharma AG, Switzerland).

Sub-Tenon's Anesthesia Technique

The STA was applied as previously described in horses by the same veterinary ophthalmologist.[25] A basic surgical instrumentation set including curved Westcott conjunctival scissors and 0,5 mm St. Martins forceps was used. Once the horse was in recumbency, the adnexa were surgically prepared with 0,05 % iodine solution (Betaisodona Solution, 1000 mg Povidon Iod Complex, Hermes Pharma, Austria), and 2 drops within 5 minutes of topical 0,5 % proxymetacaine (AlcaineÒ, Frenchs Forest, NSW, Australia, Alcon Pharma or Proparakain-POSÒ, UrsaPharm GmbH, Germany) were placed onto the cornea. The conjunctival incision was made approximately 6 – 7 mm posterior dorsal to the limbus. Closed scissors were introduced through the created aperture of approximately 5 mm and the sclera was exposed by blunt dissection through Tenon's capsule.

A 38 mm custom made sub-Tenon's cannula (Seriseal, Ophthalmic Cannula, California US Aspen Medical) (Figure 1) was inserted through the created sub-Tenon's tunnel towards the equator of the globe (Figure 2).

Once the cannula tip was beyond the globe equator, the syringe containing the local anesthetic solution was attached and slow infusion of 7 ml lidocaine 2 % (Lidocaine hydroch-



Figures 1–2: A 38 mm custom made sub-Tenon's cannula (Seriseal, Ophthalmic Cannula, California US Aspen Medical) (Figure 1) was inserted through the created sub-Tenon's tunnel towards the equator of the globe (Figure 2).

loride 20 mg/ml, AstraZeneka GmbH, Switzerland) or mepivacaine 2 % (Xylanest 2 %, mepivacaine hydrochloride 20 mg/ml, Gebro Pharma, Switzerland) began while fanning the cannula tip to maximize coverage of the intraconal region. It is critical to identify and respond to any fluid resistance or conjunctival reflux while injecting the solution. In case of reflux, the injection must be repeated. In case of fluid resistance, the cannula must be repositioned. The sub-Tenon´s tunnel should be closed by compressing the tissue with the forceps or finger.

Following STA infusion, the conjunctival incision was left unsutured and allowed to heal by second intention.

Seven eyes received 2 % lidocaine, 10 eyes received 2 % mepivacaine, respectively, due to the availability of local anesthetics in the different clinics (2 % mepivacaine was used in equine clinic 1 and 2 % lidocaine in clinic 2 and 3). Phacoemulsification and vitrectomy pars plana were performed with the Faros surgical platform (oertliÒ, Switzerland).

Outcome Assessment

Intraoperative

To evaluate and compare the effects of the two STA protocols, globe position and pupil dilation were directly observed and subjectively assessed before, during and for 24 hours after surgery. Globe position was subjectively determined to be either central or not central. Time to subjective maximal mydriasis and maximal centralization was recorded in minutes as well as the duration of maximal pupil dilation and globe centralization. The mean time and standard deviation were then calculated in minutes. Chemosis was considered to be an intraoperative complication and graded as mild, moderate and severe as previously described by Yang et al 2021.[28]

Postoperative

Patients received 1,1 mg/kg flunixine-meglumine IV q 24h (Niglumine®, flunixine-meglunime 50 mg/ml, alfavet GmbH, Germany) for two days, followed by 1 mg/kg flunixine-meglumine PO (Cronyxin flunixine 50 mg/g, Bimeda Animal Health limited, Austria) for seven days, then 0,5 mg/kg for another seven days. Postoperative antibiotic therapy for patients who underwent pars plana vitrectomy included a single IV dose of penicillin 10'000 IE/kg (Penicillin G Natrium 10 Mega IE, Sandoz, Switzerland) and gentamicin 6,6 mg/kg (Gentavan®, Gentamicin 50 mg/ml, Vana GmbH, Austria). Patients that underwent phacoemulsification were treated with a single IV dose of penicillin and gentamicin, followed by an oral treatment with 20 mg/kg trimethoprim sulfadiazin, (Equibactin® vet, 333 mg/g + 67 mg/g, Dechra, Austria) for 10 days.

Post-operative complications were recorded and considered to be short term (from day one until three months after surgery), such as temporary blindness during the recovery phase and corneal epithelial defects. Long term complica-

Table 1: Patient distribution across the lidocaine and mepivacaine groups. Breed, gender, age, affected eye and the performed surgical procedure are listed. (OD: oculus dexter, OS: oculus sinister.)

	2% Lidocaine	2% Mepivacaine
13 Horses		
Warmblood	6	2
Pura-Raza Espanola	0	2
Appaloosa	2	0
Quarter Horse	1	2
Belgian Horse	1	0
Freiburger	**0**	**1**
Gender		
Female	**6**	**4**
Male	**4**	**3**
Age		
	31 to 189 months	**33 to 206 months**
17 Eyes		
OS	**5**	**4**
OD	**5**	**3**
Procedure		
Phacoemulsification	**7**	**4**
Pars plana vitrectomy	**3**	**3**

tions (three months to six months after surgery) were low-grade retrobulbar inflammation, glaucoma, retinal detachment, and lens opacities.

Statistical Analysis

A linear model with following post-hoc analysis was used to compare the effects of lidocaine versus mepivacaine STAs on globe centralization and mydriasis using statistical software R (R Core Team (2022). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria). P-values of < 0,05 were significant. Descriptive statistics were carried out with Microsoft® Excel.

Results

The patients age ranged from five months to 15 years old. A total of 13 horses and 17 eyes underwent surgical intervention in the form of phacoemulsification (11) or pars plana vitrectomy (6). Seven horses were mares, six horses were geldings. Six breeds were represented in the study population, Warmblood horses were the most common breed.

Surgery was performed on 8 right eyes (OD) and nine left eyes (OS). Table 1 shows the distribution of the baseline variables across the two treatment groups lidocaine (7) and mepivacaine (10).

Lesions related to equine recurrent uveitis (ERU), and cataract development are briefly described in table 2 as the preoperative status of the eyes.

As represented in table 3 globe centralization was obtained in all eyes. The mean time from STA solution injection to centralization of the globe was 6 minutes (CI from 5,2 to 6,7 minutes, range: 5 - 7 minutes) with the use of 2 % lidocaine, and 8,9 minutes (CI from 7,7 to 10,1 minutes, range: 7 - 12 minutes) with the use of 2 % mepivacaine. Centralization took significantly longer following the use of mepivacaine compared to lidocaine ($p < 0,01$).

The mean duration of centralization was 15,6 minutes (CI 14,0 to 17,2 minutes, range 14 - 18 minutes) with the use of 2 % lidocaine, and 31,5 minutes (CI from 27,6 to 35,3 minutes, range: 26 - 41 minutes) with the use of 2 % mepivacaine. Centralization lasted significantly longer by an average of 16 minutes with mepivacaine compared to lidocaine ($p < 0,001$).

The mean time from injection to subjective maximal pupil dilation was significantly shorter ($p < 0,001$) with 7,1 minutes (CI from 6,5 to 7,8 minutes, range: 6 - 8 minutes) with 2 % lidocaine than 10,3 minutes (CI from 9,3 to 11,3 minutes, range 8 - 13 minutes) with 2 % mepivacaine. The duration of mydriasis however showed no statistically significant difference between the two agents ($p = 0,06$) 2 %

Table 2: Preoperative status: lesions related to equine recurrent uveitis (ERU) and cataract formation.

Case Number	Lesions
Number	
1	mature cataract, posterior synechia
2	immature cataract, suspected inherited
3	immature cataract, suspected inherited
4	mature cataract, previous suspected lens-induced uveitis
5	immature cataract, lenticonus, suspected inherited
6	congenital cataract, complete
7	congenital cataract, complete
8	congenital cataract, complete
9	congenital cataract, complete
10	severe Borrelia induced uveitis and vitritis, posterior synechia
11	2 episodes of ERU, leptospira positive status in aqueous humor (MAT)
12	multiple episodes of ERU, leptospira positive status in aqueous humor (MAT), incipient cataract, cortical secondary to uveitis
13	2 episodes of ERU, leptospira positive status (MAT) in aqueous humor
14	multiple episodes of ERU, leptospira positive status (MAT) in aqueous humor, incipient cataract, cortical secondary to uveitis, posterior synechia
15	2 episodes of ERU, leptospira positive status (MAT) in aqueous humor
16	congenital cataract, incomplete
17	congenital cataract, complete

lidocaine (40,4 minutes, CI 18,2 to 62,6 minutes) and 2 % mepivacaine (69,2 minutes, CI from 46,65 to 91,75 minutes). The onset and duration of globe centralization and mydriasis following STAs using lidocaine or mepivacaine are summarized in table 4.

All eyes demonstrated some degree of chemosis. Mild chemosis was more common in eyes anesthetized with mepivacaine (9/10) than with lidocaine (3/7). Moderate chemosis was more common in eyes treated with lidocaine STAs (3/7) than with mepivacaine STAs (1/10). Severe chemosis was observed in one eye that received a lidocaine STA. This eye suffered from low-grade retrobulbar inflammation as a long-term postoperative complication three months after surgery. The distribution of postoperative complications across the lidocaine and the mepivacaine groups, and across the pars plana vitrectomy and the phacoemulsification groups is listed in table 3.

Temporary blindness was diagnosed in three out of 10 cases that received a mepivacaine STA and resolved within 2 hours after recovery. Five eyes developed corneal epithelial defects after the surgical procedure (4/5 phacoemulsification, 1/5 pars plana vitrectomy). Five eyes emerged with a

Table 3: Eyes with diagnosis (IC: inherited cataract; CC: congenital cataract; C: cataract of unknown etiology), procedure, used anesthetic (2 % mepivacaine versus 2 % lidocaine), the time in minutes for ones and duration of centralization and mydriasis (*: incomplete) and intraoperative, acute and chronic postoperative complications.

Number of eye	Diagnosis	Procedure	Anesthetic (7 ml)	Centralization (minutes) Onset / duration	Mydriasis (minutes) Onset / duration	Complication		
						Intraoperative	Acute postoperative	Chronic postoperative
1	C	phacoemulsification	2 % mepivacaine	7/27	10/135	mild chemosis	blindness during recovery phase, corneal epithelial defect	none
2	IC	phacoemulsification	2 % mepivacaine	10/26	9/65	mild chemosis	corneal epithelial defect	lens opacity
3	IC	phacoemulsification	2 % mepivacaine	8 /38	8/85	mild chemosis	corneal epithelial defect	retinal detachment
4	C	phacoemulsification	2 % mepivacaine	8/ 41	10/80	mild chemosis	none	glaucoma, retinal detachment
5	IC	phacoemulsification	2 % mepivacaine	7 /37	10/70	mild chemosis	blindness during recovery phase	retinal detachment
6	CC	phacoemulsification	2 % lidocaine	7/18	7/60	mild chemosis	corneal epithelial defect	none
7	CC	phacoemulsification	2 % lidocaine	6/18	7/65	moderate chemosis	none	none
8	CC	phacoemulsification	2 % lidocaine	7/15	7/55	moderate chemosis	none	none
9	CC	phacoemulsification	2 % lidocaine	6/15	8/58	moderate chemosiss	none	none
10	Uveitis (Borreliosis)	pars plana vitrectomy	2 % mepivacaine	7/26	10/30	mild chemosis	blindness during recovery phase, corneal epithelial defect	none
11	ERU	pars plana vitrectomy	2 % mepivacaine	10/28	12/35	mild chemosis	none	none
12	ERU	pars plana vitrectomy	2 % mepivacaine	10/30	13/33	moderate chemosis	none	retinal detachment
13	ERU	pars plana vitrectomy	2 % lidocaine	5/15	7/15	severe chemosis	retrobulbar inflammation	lens opacity
14	ERU	pars plana vitrectomy	2 % lidocaine	5/14	8/15	mild chemosis	none	glaucoma, retinal detachment, lens opacity
15	ERU	pars plana vitrectomy	2 % lidocaine	6/14	6/15	mild chemosis	none	none
16	CC	phacoemulsification	2 % mepivacaine	10/32	10/81	mild chemosis	none	lens opacity
17	CC	phacoemulsification	2 % mepivacaine	12/32	12/78	mild chemosis	none	lens opacity

retinal detachment (3/5 phacoemulsification, 2/5 pars plana vitrectomy), five horses acquired a post-operative lens opacity, two eyes developed a post-operative glaucoma (1/2 phacoemulsification, ½ pars plana vitrectomy), and one eye developed low-grade retrobulbar inflammation. The surgical procedure was successful in all eyes, long-term complications such as retinal detachment, secondary glaucoma and lens opacity occurred after two to six months.

Discussion

The primary objective of this case series was to investigate the clinical use of sub-Tenon's blocks for surgical procedures under general anesthesia on the equine globe and to compare the effects of two external analgetic solutions on globe position and pupil dilation. Mepivacaine had a significantly longer onset of action regarding globe centration and mydriasis, but also a significantly longer duration of globe centration than lidocaine. There were no differences between solutions regarding duration of pupil dilation or the occurrence of intra- and postoperative complications. In other anatomic regions such as the distal limb, mepivacaine was demonstrated to be a superior anesthetic agent compared to lidocaine in terms of reliability and duration of action in horses.[15] Another study suggested bupivacaine to be the local anesthetic agent of choice in dogs as a result of its longer duration of action than lidocaine.[6]

Intra- and postoperative complication identification was a further aspect of this study. Statistically there was no difference concerning complications for lidocaine or mepivacaine. In this study all eyes showed some degree of chemosis. Mild chemosis is reported to occur with STA in humans with a prevalence of 5,6 % to 40 %. In a previous canine STA study by Ahn et al. [4] marked chemosis occurred in 16 of 30 dogs whereas in another canine STA study Bayley and Read reported mild chemosis intraoperatively in 58 % of the dogs, with only one case developing moderate chemosis.[6] Chemosis may occur when local anesthetic solution diffuses under the conjunctiva after STA.[17] Furthermore, conjunctival incisions are essential for pars plana vitrectomy prior to sclerotomy. Depending on the required globe manipulation chemosis may could have occurred independently from the STA. The significance of chemosis remains unknown. Chemosis as an intraoperative complication can interfere with surgical procedures and can lead to corneal ulceration.[7,11,28] To minimize chemosis as an intraoperative complication, the STA could be divided into two half volume injections at different locations away from the surgical site. The inferonasal approach for STA application was considered inappropriate in a previous study due to technical difficulties as a result of eyeball rotation in the medioventral direction under general anesthesia.[3] Alternative STA application sites, and a possible division of the STA volume over two injection sites should be evaluated further.[3]

Corneal epithelial defects are a risk with every ophthalmic procedure. In this case series it seems to be a common complication occurring in 29 % of the eyes. Four out of five cases were associated with the phacoemulsification procedure. Chemosis as well as the impact of the surgery itself are described as possible causes for corneal ulceration in the literature.[28]

One patient was diagnosed with a severe post-operative, retrobulbar inflammation three months after surgery, which resolved through a 20-day treatment with systemic antibiotics and NSAIDs. The same horse was rated with severe intraoperative chemosis, and had received a 2 % lidocaine STA. No previous reports of retrobulbar inflammation were found in veterinary patients after STA injections. A possible retrobulbar bacterial cellulitis due to lidocaine solution contamination may have been the reason for this postoperative retrobulbar inflammation, although the timeframe between the STA and overt retrobulbar inflammation seems long.

The long-term postoperative complications such as retinal detachment (five of 17), progressive lens opacity or (five out of 17) and secondary glaucoma (two out of 17) are most likely complications to the surgical procedures that were performed (phacoemulsification or pars plana vitrectomy). These complications occurred between two and six months

Table 4: The onset and duration of globe centralization and mydriasis following Sub-Tenon's anesthesia (STA) using lidocaine or mepivacaine. The statistical significance of differences between lidocaine and mepivacaine treated eyes is indicated.

	2% lidocaine	2% mepivacaine	P-value
Centralization			
Onset	6 ± 0,75 (5-7)	8,9 ± 1,23 (7-12)	<0,01
Duration	15,6 ± 1,56 (14 – 18)	31,5 ± 3,9 (26 – 41)	<0,001
Mydriasis			
Onset	7,1 ± 0,64 (6 – 8)	10,3 ± 1 (8 – 13)	<0,001
Duration	40,4 ± 22,2 (15 – 65)	69,2 ± 22,5 (30 – 135)	0,06

after surgery, and their correlation to the STAs cannot be established.

Standing sedation is commonly used for corneal surgeries, laser ablation of granula iridica cysts or procedures used to manage equine glaucoma.[14,20] Retrobulbar nerve blocks are usually the local anesthetic procedure of choice in these scenarios.[27] As STA is reported to be superior in dilating the pupil in comparison to retrobulbar block anesthesia in previous canine studies of Ahn et. al and Bayley and Read.[2–4,6], and since globe centralization occurred in all cases in this study, STA may be a feasible technique for standing procedures. Desensitization of the cornea and globe may be valid parameters to evaluate during STAs in standing corneal surgeries. Further investigation into the feasibility of STAs as anesthetic tool during standing procedures is warranted.

Intraocular pressure was not assessed as an intraoperative parameter, which is a weakness of this study. Significant raises in IOP due to STAs have not been reported in dogs, and the injection solution volume has been proposed to exert a positive effect on globe position in canine breeds with deep orbits.[3,6] The effect of STA on the IOP in horse eyes has not been investigated and should be considered as endpoint measurement in future studies. Further limitations are the retrospective nature of this study, precluding the use of standardized general anesthesia protocols or control groups. The used sedatives and their different vasopressive characteristics could have influenced the efficacy of the anesthetic agents. Furthermore, pupil dilation and the centralization of the globe were only assessed subjectively.

Conclusion

To the authors' knowledge this is the first publication on the clinical use of STA in equine patients. In the cases described in this manuscript, STA was a feasible procedure to reach the akinesia and pupil dilatation needed for the surgical procedures performed (phacoemulsification and pars plana vitrectomy) on these equine eyes. Although a direct in vivo comparison to systemic neuromuscular blocking agents or retrobulbar block anesthesia is not currently available, the authors suggest that STA can be considered to be a feasible and reliable alternative.

Acknowledgments

The authors would like to thank the owners of the patients that were enrolled in this study for their consent and participation. The authors did not receive financial support for the study and do not have any financial interests in the tested technique or material presented. The authors would like to thank Michael DeCamp, EAGLE LABS (USA), for producing the custom-made 38 mm Sub Tenon's needle. This data was included in an abstract presentation at the 2023 IEOC conference in Edinburgh, Scotland.

Conflict of Interest

The authors have no conflict of interest to declare.

Anesthésie sous-ténonienne dans la chirurgie de la cataracte et la vitrectomie équines: une série de cas rétrospectifs (2018–2022)

L'objectif de cette étude était d'étudier l'utilisation clinique des blocs sous-ténoniens pour les procédures chirurgicales sous anesthésie générale sur le globe oculaire équin.

Une analyse rétrospective des données a été réalisée sur 17 yeux de 13 chevaux ayant subi une injection sous-ténonienne pour faciliter la phacoémulsification ou la vitrectomie par la pars plana sous anesthésie générale entre 2018 et 2022. Toutes les procédures ont été réalisées par le même vétérinaire ophtalmologiste. Sept yeux ont reçu une dose sous-ténonienne de 7 ml de lidocaïne (Xylocain Ò, chlorhydrate de lidocaïne à 2 %, Allemagne, Aspen Germany GmbH), et 10 yeux ont reçu 7 ml de mépivacaïne (Mepinaest Ò purum 2 %, chlorhydrate de mépivacaïne, Suisse, Gebro Pharma GmbH). L'analyse statistique a comparé l'apparition et la durée de la centralisation du globe et de la mydriase de la pupille entre les deux groupes. Les complications peropératoires et postopératoires ont également été évaluées.

La mépivacaïne a eu un début d'action significativement plus tardif en ce qui concerne le centrage du globe et la mydriase (8,9 minutes contre 6 minutes), mais aussi une durée de centrage du globe significativement plus longue que la lidocaïne (31,5 minutes contre 15,6 minutes). Il n'y a pas eu de différences statistiquement pertinentes entre les produits en ce qui concerne la durée de la dilatation de la pupille (40,4 minutes pour la lidocaïne à 2 % contre 69,2 minutes pour la mépivacaïne à 2 %). Une chémose s'est produite dans les 17 yeux. Les complications chirurgicales comprenaient des défauts de l'épithélium cornéen (5), un décollement de la rétine (5), une opacification du cristallin (5), une cécité temporaire pendant la convalescence (3) et un glaucome (2).

L'anesthésie sous-ténonienne est une alternative possible au blocage neuromusculaire systémique et à l'anesthésie par bloc rétrobulbaire pour les interventions chirurgicales sur le globe oculaire équin. Une étude prospective contrôlée in vivo est nécessaire pour mieux évaluer les effets et les risques.

Mots clés: sous-ténonienne, cheval, anesthésique local, lidocaïne, mépivacaïne, chirurgie ophtalmique

Anestesia sottotenoniana nella chirurgia della cataratta e di vitrectomia negli equini: uno serie retrospettiva di casi (2018–2022)

Lo scopo di questo studio era di indagare l'uso clinico dei blocchi sottotenoniani per procedure chirurgiche sotto anestesia generale sul globo oculare equino.

È stata condotta un'analisi retrospettiva dei dati su 17 occhi di 13 cavalli sottoposti a un'iniezione sottotenoniana per facilitare la facoemulsificazione o la vitrectomia pars plana sotto anestesia generale tra il 2018 e il 2022. Tutte le procedure sono state eseguite dallo stesso oculista veterinario. Sette occhi hanno ricevuto una dose sottotenoniana di 7 ml di lidocaina (XylocainÒ, lidocaina cloridrato al 2 %, Germania, Aspen Germany GmbH), e 10 occhi hanno ricevuto 7 ml di mepivacaina (MepinaestÒ purum 2 %, mepivacaina cloridrato, Svizzera, Gebro Pharma GmbH). L'analisi statistica ha confrontato l'insorgenza e la durata della centralizzazione del globo oculare e della midriasi pupillare tra i due gruppi. Sono state valutate anche le complicazioni intraoperatorie e postoperatorie.

La mepivacaina ha mostrato un'insorgenza significativamente più tardiva riguardo alla centralizzazione del globo oculare e alla midriasi (8,9 minuti contro 6 minuti), ma una durata significativamente più lunga della centralizzazione del globo rispetto alla lidocaina (31,5 minuti contro 15,6 minuti). Non sono state riscontrate differenze statisticamente rilevanti tra le due soluzioni riguardo alla durata della dilatazione pupillare (40,4 minuti per la lidocaina al 2 % contro 69,2 minuti per la mepivacaina al 2 %). La chemosi si è verificata in tutti i 17 occhi. Le complicazioni chirurgiche includevano difetti epiteliali corneali (5), distacco retinico (5), opacità del cristallino (5), cecità temporanea durante il recupero (3) e glaucoma (2).

L'anestesia sottotenoniana è risultata quindi un'alternativa praticabile al blocco neuromuscolare sistemico e all'anestesia con blocco retrobulbare per le procedure chirurgiche sul globo oculare equino. È necessario uno studio controllato prospettico in vivo per valutare ulteriormente effetti e rischi.

Parole chiave: sottotenoniana, cavallo, anestetico locale, lidocaina, mepivacaina, chirurgia oftalmica

Sub-Tenon's Anesthesia in Equine Cataract Surgery and Vitrectomy: A Retrospective Case Series (2018–2022)

O. Kiesse, P. Torgerson, S. A. Pot, S.Stadler

Literaturnachweis

[1] Accola PJ, Bentley E, Smith LJ, Forrest LJ, Baumel CA, Murphy CJ: Development of a retrobulbar injection technique for ocular surgery and analgesia in dogs. *Journal of the American Veterinary Medical Association* 2006: 229(2): 220–225.

[2] Ahn J, Jeong M, Lee E, Kim S, Park S, Park S, et al.: Effects of peribulbar anesthesia (sub-Tenon injection of a local anesthetic) on akinesia of extraocular muscles, mydriasis, and intraoperative and postoperative analgesia in dogs undergoing phacoemulsification. *American journal of veterinary research* 2013: 74(8): 1126–1132.

[3] Ahn J, Jeong M, Park Y, Lee Y, Lee E, Kim S, et al.: Comparison of systemic atracurium, retrobulbar lidocaine, and sub-Tenon's lidocaine injections in akinesia and mydriasis in dogs. *Veterinary ophthalmology* 2013: 16(6): 440–445.

[4] Ahn J, Jeong M, Park Y, Lee Y, Lee E, Kim S, et al.: A sub-Tenon's capsule injection of lidocaine induces extraocular muscle akinesia and mydriasis in dogs. *The Veterinary Journal* 2013: 196(1): 103–108.

[5] Baake EI, von Borstel M, Rohn K, Boevé MH, Ohnesorge B: Long-term ophthalmologic examinations of eyes with equine recurrent uveitis after pars plana vitrectomy. *Pferdeheilkunde* 2019: 35(3): 220–233.

[6] Bayley KD, Read R: Sub-Tenon's anesthesia for canine cataract surgery. *Veterinary ophthalmology* 2018: 21(6): 601–611.

[7] Boss C, La Croix N, Moore PA, Wilkie DA, Maggio F, Wiggans KT, et al.: Preliminary report of postoperative complications of phacoemulsification in Pugs: A multicenter retrospective study of 32 cases. *Veterinary ophthalmology* 2020: 23(3): 442–449.

[8] Brooks DE, Plummer CE, Carastro SM, Utter ME: Visual outcomes of phacoemulsification cataract surgery in horses: 1990–2013. *Veterinary Ophthalmology* 2014: 17: 117–128.

[9] Chua MJ, Lersch F, Chua AW, Kumar CM, Eke T: Sub-tenon's anaesthesia for modern eye surgery—clinicians' perspective, 30 years after re-introduction. *Eye* 2021: 35(5): 1295–1304.

[10] Edelmann ML, McMullen Jr R, Stoppini R, Clode A, Gilger BC: Retrospective evaluation of phacoemulsification and aspiration in 41 horses (46 eyes): visual outcomes vs. age, intraocular lens, and uveitis status. *Veterinary ophthalmology* 2014: 17: 160–167.

[11] Fenollosa-Romero E, Jeanes E, Freitas I, Enache AE, Lockhart R, Fleming L, et al.: Outcome of phacoemulsification in 71 cats: A multicenter retrospective study (2006-2017). *Veterinary ophthalmology* 2020: 23(1): 141–147.

[12] Fruehauf B, Ohnesorge B, Deegen E, Boeve M: Surgical management of equine recurrent uveitis with single port pars plana vitrectomy. *Veterinary Ophthalmology* 1998: 1(2-3): 137–151.

[13] Guise PA: Sub-Tenon anesthesia: a prospective study of 6,000 blocks. *The Journal of the American Society of Anesthesiologists* 2003: 98(4): 964–968.

[14] Hermans H, Lloyd-Edwards RA, Ferrão-van Sommeren AJ, Tersmette AA, Schouten JC, Serra Bragança FM, et al.: Comparing Blind and Ultrasound-Guided Retrobulbar Nerve Blocks in Equine Cadavers: The Training Effect. *Animals* 2022: 12(2): 154.

[15] Hoerdemann M, Smith RL, Hosgood G: Duration of action of mepivacaine and lidocaine in equine palmar digital perineural blocks in an experimental lameness model. *Veterinary Surgery* 2017: 46(7): 986–993.

[16] Jeganathan VSE, Jeganathan VP: Sub-Tenon's anaesthesia: a well tolerated and effective procedure for ophthalmic surgery. *Current opinion in ophthalmology* 2009: 20(3): 205–209.

[17] Kumar C, Eid H, Dodds C: Sub-Tenon's anaesthesia: complications and their prevention. *Eye* 2011: 25(6): 694–703.

[18] Lee RM, Thompson JR, Eke T: Severe adverse events associated with local anaesthesia in cataract surgery: 1 year national survey of practice and complications in the UK. *British Journal of Ophthalmology* 2016: 100(6): 772–776.

[19] Lerch D, Venter JA, James AM, Pelouskova M, Collins BM, Schallhorn SC: Outcomes and adverse events of sub-tenon's anesthesia with the use of a flexible cannula in 35,850 refractive lens exchange/cataract procedures. *Clinical Ophthalmology* 2020: 307–315.

[20] McKinney R: The retrobulbar block: A review of techniques used and reported complications. *Equine Veterinary Education* 2021: 33(6): 332–336.

[21] Ripart J, Benbabaali M, Muller L: Sub-Tenon's anesthesia. *Ophthalmology* 2002: 109(2): 215–216.

[22] Roman SJ, Sit DAC, Boureau CM, Auclin FX, Ullern MM: Sub-Tenon's anaesthesia: an efficient and safe technique. *British journal of ophthalmology* 1997: 81(8): 673–676.

[23] Savino G, Perrotta V, Colucci D, Balia L, Sammartino M, Garra R, et al.: Mydriasis induced by sub-Tenon's ropivacaine injection in patients undergoing strabismus surgery. *Journal of American Association for Pediatric Ophthalmology and Strabismus* 2010: 14(2): 124–126.

[24] Shilo-Benjamini Y: A review of ophthalmic local and regional anesthesia in dogs and cats. *Veterinary anaesthesia and analgesia* 2019: 46(1): 14–27.

[25] Stadler S, Dennler M, Hetzel U, Del Chicca F, Hoey S, Spiess BM, et al.: Sub-Tenon's injection in equine cadaver eyes: MRI visualization of anesthetic fluid distribution and comparison of two different volumes. *Veterinary ophthalmology* 2017: 20(6): 488–495.

[26] Toemoerdy E, Haessig M, Spiess BM: The outcome of pars plana vitrectomy in horses with equine recurrent uveitis with regard to the presence or absence of intravitreal antibodies against various serovars of Leptospira interrogans. *Pferdeheilkunde* 2010: 26(2): 251–254.

[27] Tremaine W: Local analgesic techniques for the equine head. *Equine Veterinary Education* 2007: 19(9): 495–503.

[28] Yang VY, Eaton JS, Harmelink K, Hetzel SJ, Sanchez A, Lund JR, et al.: Retrobulbar lidocaine injection via the supraorbital fossa is safe in adult horses but produces regionally variable periocular anaesthesia. *Equine Veterinary Journal* 2022: 54(4): 807–819.

Korrespondenzadresse

Silvia Stadler
DVM, Dipl. ACVO, Pferdeklinik Tillysburg,
Bruck bei Hausleiten 11,
AUS-4490 Austria
Tel: +43 660 12 12 632
Email: stadler@pferdeklinik.at