Dorothy Havemeyer Equine Ophthalmology Symposium

The Grand Hotel
Malahide, Ireland

June 2-4, 2016
The goal of this symposium is to share, with a small group of dedicated clinicians and scientists, current clinical and basic research on equine ophthalmology. Abstract and case presentations, along with social events, will facilitate the development of multi-centered collaborative research.

This symposium is sponsored by:

Exhibitors

**MLT GmbH**
Medizinische Laser Technologie GmbH
Turnierstraße 9a
D-55218 Ingelheim
(+49) 06132/ 433 025
### SYMPOSIUM PROGRAM

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<td>Tara 1</td>
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<tr>
<td>9:00am-10:00am</td>
<td>Tara 1</td>
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<td>&quot;The if's, and's, and but(t)'s of standing ophthalmic surgery in the sedated horse&quot;</td>
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"The If's, And's, and But(t)’s of Standing Ophthalmic Surgery in the Sedated Horse"

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Richard McMullen, Dr. med. vet. graduated from the Veterinary Medicine Faculty of the University of München, Germany in 2002 and immediately joined the University's Clinic for Horses, as a doctoral candidate. He obtained his doctorate in 2005 evaluating the role of equine adenoviruses in cases of putative viral keratitis or keratopathies. In 2006 he obtained advanced certification in equine ophthalmology, in Germany (Zusatzbezeichnung Augenheilkunde Pferd), followed by a residency in Comparative Ophthalmology at North Carolina State University (NCSU), in Raleigh, North Carolina, from 2006 to 2009. He remained on faculty at NCSU as an Assistant Professor of Ophthalmology from 2009 until November 2012. Dr. McMullen is a Diplomate of both the American and European Colleges of Veterinary Ophthalmologists (ACVO and ECVO). In January 2013 he joined the Equine Clinic München-Riem where he has established and runs the Equine Ophthalmology Service, one of the few equine-only ophthalmology services in the world. He has published several articles and book chapters within his equine research areas of interest: Intraocular lens development and phacoemulsification in the horse, equine vision and streak retinoscopy, the clinical use of digital infrared photography to enhance the diagnosis and monitor progression of various ophthalmic diseases, the evaluation of endoscopic laser cyclophotocoagulation (ECP), and standing ophthalmic surgery in the horse.
THE IF’S, AND’S, AND BUT(T)’S OF STANDING OPHTHALMIC SURGERY IN THE SEDATED HORSE

Richard J. McMullen Jr., Dr. med. vet.
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Adjunct Assistant Professor of Ophthalmology,
North Carolina State University, Raleigh, NC, USA
Equine Ophthalmology Service,
Equine Clinic Munich-Riem, Munich, Germany
Email: rjmcmull@ncsu.edu

INTRODUCTION

Equine surgery is increasingly being performed on horses under sedation, and ophthalmic surgery is no exception. The goal of this presentation is not to provide step-by-step instructions on how to perform a specific list of equine ophthalmic surgical procedures. Rather, an attempt will be made to point out misconceptions associated with standing ophthalmic surgery, as well as prerequisites and pitfalls associated with standing ophthalmic surgery in the horse. The presentation will be broken down into three individual sections: 1) Microsurgical training as a prerequisite, including surgical planning and preparation; 2) Patient positioning, sedation and local anesthetic techniques necessary to facilitate consistently predictable and positive surgical outcomes; and 3) The scope of ophthalmic surgical procedures currently being performed in my practice and the real and perceived complications associated with them.

Motivation for performing standing ophthalmic surgery in the horse is multifaceted. Ophthalmic surgical procedures performed under sedation and local anesthesia are attractive, as it is possible to completely avoid the risks associated with general anesthesia. While this reason alone is sufficient enough to justify standing ophthalmic surgery in many cases, it inadequately reveals the many, subtle, benefits of sedation and local anesthesia, of which there are several. Standing ophthalmic surgery under sedation allows ALL of the risks associated with general anesthesia (i.e., induction, time on the surgical table, and the recovery period) to be avoided. Additionally, because sedatives and local anesthetic agents are very effective and well tolerated, acceptable immobilization necessary for well-controlled surgical intervention can be achieved in many cases. The horse’s passive stay apparatus makes this species unique candidates for many types of surgery under sedation. There are increasingly large numbers of both non-ophthalmic and ophthalmic surgeries routinely performed under sedation and local anesthesia.

More subtle, and less obvious, benefits of surgery understanding sedation is the limited risk of secondary complications associated with recovery from general anesthesia and the added benefit of owner compliance should a second, or third surgery be required. Putting a horse under general anesthesia greatly increases the risks of secondary complications, such as: myopathy, pneumonia (associated with intubation), skeletal injury, thrombophlebitis, and gastrointestinal complications. In addition to the previous complications, rough and/or prolonged recovery can also lead to significant complications following delicate intraocular (e.g., cataract surgery, gonio-shunt placement, vitrectomy, etc.) such as intraocular hemorrhage.
Equine ophthalmic surgery, as in all other species, is microsurgery requiring adroit handling of delicate tissue and the use of small and fragile suture material. Ophthalmic surgery performed on standing and sedated horses should not be viewed as a compromise in treatment for the sake of avoiding general anesthesia, but rather as a means of implementing delicate and precise surgical procedures on an animal capable of standing, relatively still, while sedated. The fact that general anesthesia and the associated risks of secondary complications, including those associated with both the induction and recovery phases, are an added bonus. A perfect example of such a situation is gonio-shunt placement. Both meticulous attention to detail and precise microsurgical technique are required, and even the best surgical results can be compromised with one misstep during recovery from surgery. Even when significant precautions are taken to ensure a smooth recovery, this is not always possible. Placement of a gonio-shunt under standing sedation and local anesthesia, when well controlled, entirely eliminates the risks of secondary complication occurring during the postoperative recovery phase following surgery under general anesthesia.

Standing ophthalmic surgery can be effectively carried out with as few as two people, as long as surgical candidates are appropriately selected. This is especially true, if the horse’s head is stabilized on a stable cart with wide (cushion) support and appropriate planes of sedation and local anesthesia are maintained throughout the procedure. There is huge potential for complications especially if the surgeon is ill-prepared or ignorant of the specific pitfalls associated with specific procedures.

PATIENT SELECTION

Patient selection is a key element in ensuring positive surgical outcomes. While not “problem” horses can be detected prior to sedation, standing ophthalmic surgery should be avoided in those horses with obvious behavioral problems. A known history indicating difficulties in treating a horse for other ailments under sedation should not be taken lightly and is a good indication that general anesthesia would be more appropriate should ophthalmic surgical intervention be indicated. Should a horse’s difficulty to be appropriately treated under sedation become obvious only after being sedated, the procedure should be aborted. The horse can then either go directly into induction for anesthesia or an alternative appointment for surgery under general anesthesia should be scheduled.

SEDATION AND ANALGESIA

Once patient selection has occurred and a general physical examination rules out contraindications for surgery, sedation is achieved with one, or more frequently, a combination of medications can be initiated. Generally, analgesia is provided using systemic nonsteroidal anti-inflammatory medications (NSAIDs) systemically in addition to local analgesia facilitated by local nerve blocks. While opioids, such as butorphanol have generally been avoided for standing ophthalmic procedures due to subsequent head-bobbing, there are several indications for its use. Minimizing the amount of butorphanol administered intravenously (i.v.) and giving an intramuscular (i.m.) bolus injection can positively influence the effects of sedation. Characteristic “head-bobbing” is commonly only significant during the first 5-10 minutes following i.v. administration and subsides thereafter. Generally, administering local eyelid and retrobulbar blocks, obtaining ophthalmic photographs and prepping the eye and surrounding site appropriately for sterile surgery will take at least 15 minutes, at which time any residual head-bobbing will be minimal and is unlikely to negatively influence the surgery.
Alpha-2 agonists provide good short-term analgesia and reliably consistent sedation. In general, alpha-2 agonists (e.g., detomidine 0.01-0.02 mg/kg) are administered i.v. to facilitate rapid onset of effect and to provide consistent and predictable results. Additionally, we have found the use of subcutaneous (s.c.) administration of detomidine (0.03 mg/kg) to be beneficial in providing more profound sedation while also extending the duration of effect, especially when combined with i.v. administration. Although constant rate infusions are not utilized in our practice, their use for standing surgery in the horse is quite widespread.

**REGIONAL NERVE BLOCKS**

The most common local blocks utilized for ophthalmic diagnostic and surgical procedures are the palpebral (auriculopalpebral) and supraorbital (frontal) nerve blocks. For many surgical procedures additional analgesia and regional anesthesia can be achieved using a retrobulbar block and topical corneal and conjunctival anesthesia. Lidocaine is a commonly utilized local anesthetic that is valued for its quick onset of action (5-15 min) as well as its duration of action (60-120 min). However, lidocaine can be locally irritating and may cause hypersensitive tissue reactions resulting in significant chemosis. These negative effects can be all but eliminated with the use of mepivacaine. Mepivacaine also has a relatively short onset of action (5-30 min) and an extended duration of action (90-180 min) compared with lidocaine. Longer acting local anesthetics with a prolonged onset of action, such as bupivacaine, are not routinely utilized but may be indicated following enucleation, where prolonged analgesia is desired. Additional local eyelid blocks, such as eyelid line blocks and lacrimal, zygomatic and infratrochlear nerve blocks can be strategically utilized, should further regional anesthesia be desired.

**STERILE PREPARATION, ASSISTANCE AND PATIENTRESTRAINT/SUPPORT**

All of the necessary supplies and instruments necessary should, ideally, be neatly arranged and within reach before the onset of the procedure. This small step saves time, increases efficiency, and facilitates logical and sequential implementation of the surgical procedure being carried out. Generally, standing ophthalmic surgical procedures in my practice are carried out by two individuals (myself and an assistant), occasionally, a third person (often the owner) will be available. As a rule, we do not utilize stocks for ophthalmic surgery, choosing instead to have the horse positioned within it’s stall with it’s front feet and head just outside in the stall aisle. The head is positioned on stack of custom made pads placed on top of a mobile cart. With the head supported in this fashion, the head is much more stable, and the horse calmer than if the head were being supported by a person or instable stand (dental stands generally not as effective). Following local eyelid blocks (+/- retrobulbar block, depending on the procedure) and clipping of the periocular hair, aseptic preparation is carried out. A three-step surgical site preparation is performed sequentially using dilute baby shampoo followed by a 1%-5% povidone-iodine scrub, and completed with a sterile saline solution. The conjunctival fornix is prepped similarly and the head is draped with a self-adhesive aperture drape. For many procedures an eyelid speculum is placed within the palpebral fissure to facilitate exposure of the surgical site. In some instances, Intravitreal injections or aqueocentesis, a Demarres eyelid holder is sufficient.

**OPHTHALMIC MICRO SURGERY**

Meticulous attention to detail and a complete understanding of the principles of microsurgery are essential, not only to ensure the best possible outcome following ophthalmic surgery on standing and sedated patients, but also for the ophthalmic surgeon to accurately anticipate and avoid situations that may cause secondary complications or necessitate changes in the
planned procedure. Because of the positional differences, dictated by the horse’s head being in a vertical, as opposed to a horizontal position, alterations in magnification, surgical instrumentation and technique are often necessary to facilitate a quick and seamless surgical procedure.

**Magnification**
Magnification is the first aspect of microsurgery that is compromised when performing standing ophthalmic surgery in the horse. Even if a head-mounted microscope is utilized, a dramatic reduction in magnification compared with a floor or ceiling mounted microscope utilized in a standard ophthalmic surgery suite. Generally, head loupes (Galilean, 2.3x to 2.5x or prismatic 3.5x to 6.0x surgical loupes) are utilized for equine ophthalmic surgery performed under sedation. Both types of loupes have both advantages and disadvantages and surgeon preference will play an extremely important role in which type is utilized. Galilean surgical loupes are smaller, lighter, and have a larger field of view than prismatic surgical loupes. Although the degree of magnification is less with Galilean surgical loupes, the ability to visualize or perceive the surgeon’s surroundings while wearing the loupes is much greater than with prismatic surgical loupes. This is not a small advantage when performing delicate surgery on a large and sometimes unpredictable animal. While a light-weight surgical head-mounted microscope would be very advantageous with regards to surgical precision the only model currently available (M5 Varioscope, Leica, with 2.0x – 9.0x optical zoom) requires electricity from a cable restricting range of movement.

**Microsurgical Instrumentation**
Instrumentation for equine ophthalmic microsurgery is highly specialized, and although the necessary instruments are familiar to ophthalmologists trained in microsurgery, many of the familiar instruments must be modified, even if only slightly, in order to facilitate efficient use in the horse. While many instruments can be utilized without modification, slight modifications, such as extending the handle length, have a profoundly positive influence on the surgical outcome, especially in horses undergoing surgery understanding sedation.

**Microsurgical Training**
Complete understanding of microsurgical principles is necessary to ensure selection of the most appropriate surgical procedure for the specific disease/situation and will allow the ophthalmic surgeon to make necessary modifications to existing procedures for use in standing/sedated horses. Specific modifications in surgical procedure and instrumentation selection will often provide the basis for successful surgical outcomes equaling and even surpassing results obtained under general anesthesia.

Surgical planning is important when contemplating standing ophthalmic surgery, as there are certain time and positional restrictions that influence various procedures. Although, head positioning is important in every type of ophthalmic surgical procedure, this is especially true of standing procedures as globe access is limited due to the vertical orientation of the head and the surgeons decreased access due as a result of his/her position next to the horse, as opposed to “hovering” above the horse, as is the case during ophthalmic surgery performed under general anesthesia. Vertical globe rotation can be greatly facilitated by rotating the ears away from the surgeon to expose the superior globe and rotating the ears toward the surgeon to expose the inferior globe. Intrascляр stay sutures (4-0 silk, Catgut, Markneukirchen, Germany) placed strategically along the limbus can also be utilized to facilitate further and more specific rotation of the globe necessary for specific procedures (e.g., placement of a gonio-shunt or suprachoroidal cyclosporine implant).
Placing corneal sutures is a perfect example where patience, skill and experience are all equally important. If the surgeon does not understand the process of how a microsurgical needle passes through the corneal stroma, and what steps are necessary to achieve the expected results, he or she may consistently place sutures at too great of an interval from the neighboring sutures or at an inappropriate depth; resulting in inadvertent needle penetration into the anterior chamber. Such a situation may, occasionally even under the most ideal circumstances, occur. Without a good understanding of microsurgical procedure and significant experience the mistake may go undetected, the consequences of which may be devastating. The application of concentrated fluorescein (e.g., Seidel test) allows for rapid identification of aqueous humor leakage from the anterior chamber. Failure to remove and replace the suture in question with a new suture at the appropriate stromal depth may result in continuous aqueous humor leakage through the needle tract, possibly leading to hypotony, wound or suture dehiscence, or possibly secondary intraocular infection that may progress to endophthalmitis.

In addition to surgical technique, proper suture material and needle selection for the specific procedure is of paramount importance. It should be noted that if a surgeon is not comfortable or experienced with the use of microsurgical suture material (7-0, 8-0, 9-0), then they should probably not be attempting to perform corneal ophthalmic microsurgery in the horse. Small and delicate spatula needles are important to achieve placement of corneal sutures at the appropriate depth within the cornea, and utilizing the smallest size suture possible will minimize corneal tissue reaction and long-term scarring. The use of 8-0 or 9-0 resorbable or non-resorbable suture to facilitate corneal microsurgery in the standing sedated horse requires significantly honed surgical skills, appropriate magnification, and a cooperative horse (made cooperative through profound sedation and local anesthesia). Such suture material is extremely delicate and will break easily with improper technique or uncontrolled head movements that may not be avoidable. Improper suture handling (leads to suture damage due to incorrect instrument selection or implementation) must be avoided at all cost.

**CATEGORIES OF EQUINE OPHTHALMIC SURGERY**

The following four categories represent the scope of ophthalmic surgery performed in my current practice using skills learned and honed over the past decade. Don’t let the category names mislead you; even minimally invasive (Category I) and simple (Category II) procedures require a significant amount of training and experience to perform consistently well. Their names were chosen as a result of the amount of special instrumentation necessary to perform them and if sutures are necessary.

**Category I: MINIMALLY INVASIVE**
The procedures in this category are quickly performed, often not requiring retrobulbar blocks, and utilize modified but profound sedation and local anesthesia to facilitate them. Examples: *aqueous paracentesis, intravitreal injections, episcleral cyclosporine implant placement, diamond burr keratotomy.*

**Category II: SIMPLE**
These procedures require more advanced instrumentation and take more time to complete than the procedures in Category I. Examples: *enucleation, nictitans excision, eyelid neoplasia, laser ablation of iris/uveal cysts, transscleral cyclophotocoagulation (TSCPC).*
**Category III: ADVANCED**
The surgical procedures in this category often require suturing and precise surgical excision within very thin and delicate ocular tissue. Examples: *superficial lamellar keratectomy, grafting procedures (conjunctiva, amniotic membrane, BioSiSt, A-cell), intrastromal injections, glaucoma shunt bleb deroofing.*

**Category IV: COMPLICATED**
These surgical procedures are highly specialized requiring a significant level of experience and microsurgical expertise, patience and intuition. Examples: *Suprachoroidal cyclosporine implant placement, lamellar keratoplasties (deep lamellar endothelial keratoplasty, DLEK; posterior lamellar keratoplasty, PLK; corneoconjunctival transposition, CCT), gonio-shunt placement.*

**STANDING OPHTHALMIC MICROSURGERY COMPLICATIONS**

Complications associated with standing ophthalmic surgery in the horse can be categorized as follows: complications associated with sedation, complications associated with local anesthesia, iatrogenic or intraoperative complications and postoperative complications. Currently, the data regarding complications associated with standing sedation and ophthalmic surgery in the horse have not been critically evaluated. However, the actual complication rate appears to be much lower than the perceived rate, with most complications being relative minor in nature.

**Complications associated with sedation**
There are generally two types of complications associated with sedation: spontaneous recumbency or excessive movement. While unexpected recumbency is quite dramatic when it occurs, generally, waiting for the effects of sedation wear off and providing assistance in standing are all that is required. Unless the horse collides with an immobile or sharp object on the way down, the consequences are minimal. Excessive movement can generally be anticipated but may catch the ophthalmic surgeon off-guard, especially if she/he is relatively inexperienced. The true risks associated with excessive movement are secondary or iatrogenic complications caused by inadvertent tissue damage from ophthalmic instruments or immobile objects within the area where the surgery is being performed. Being cognizant of signs of inappropriate or waning sedation (ear movement, vocalization, restlessness) will generally result in recognizing when additional sedation is needed and prevent such complications.

An indirect indication that the plane of sedation is no longer appropriate is manifest as resistance from the horse against attempts to manually reposition the head. Although the horse may be relatively still and cooperative immediately prior to repositioning (albeit in an inappropriate or inadequate position for the specific step in the surgery), if the plane of sedation has become too light the horse will often demonstrate resistance by moving in the opposite direction or lifting its head. While not necessarily a complication many unforeseen problems (e.g., break in sterility, inadvertent iatrogenic injury to ocular or adnexal tissue, etc.) may occur as a result.

**Complications associated with local anesthesia**
Complications associated with local anesthesia result in local hyperthermia and sweating at/around the infiltration site and or mild/moderate/marked chemosis due to local hypersensitivity. Fortunately, utilizing mepivacaine, as opposed to lidocaine has virtually eliminated marked chemosis or local tissue reactions at the injection sites due to
hypersensitivity. However, we do still see some excessive chemosis following improper placement of the local anesthetic agent following retrobulbar block.

**Latrogenic or intraoperative complications**
Latrogenic or intraoperative complications are generally induced by head movement at an inappropriate moment in the surgical procedure. For example, while placing a corneal suture the horse spontaneously moves toward the needle. Such movement might possibly result in corneal perforation of the suture needle if the surgeon is not anticipating such a movement. It is important to mention that these types of complications rarely occur when surgery is performed by an experienced and highly trained ophthalmologist because these types of movements are constantly being anticipated and the surgeon instinctively moves her/his hands away from the eye.

**Postoperative complications**
These types of complications are generally closely associated with the surgical procedure that has been performed and while these are some of the more frequent types of complications they are generally not severe or debilitating and it is very difficult to determine if the complication is actually a result of surgical intervention due to the specific surgical procedure implemented or if the complication is a direct result of ophthalmic surgery performed under sedation and local anesthesia.

**CONCLUSION**
In just about every way, microsurgery in standing and sedated horses is different from the same procedure performed under general anesthesia. Not only in a theoretical, but also in a practical manner. Microsurgical procedures performed under sedation require a significantly altered approach. First, and foremost, visualization is different and it is much more difficult to properly support your forearms due to the upright position of both the surgeon and the horse. As a result, alternative points of contact are utilized to allow for “on-the-fly” adjustments or reactions to sudden or unexpected movement from the horse. Not being prepared for or failing to anticipate head movement from the horse may result in some very serious intraoperative iatrogenic complications. However, with proper preparation and anticipation of movement, along with the use of strategically applied local anesthetics, relatively controlled surgical parameters may be achieved. It is important to note that the anticipation of any and all possible theoretical complications that may occur is the best possible way to avoid significant and “real” complications. Patience is a virtue that every surgeon considering standing ophthalmic surgery must possess. Impatience leads to frustration and increases the risk of complications, and may negatively influence results of the surgical procedure on the immediate, short- and long-term post-operative results.
ADDITIONAL READING


FRIDAY SESSION
ABSTRACTS & CASE REPORTS
Purpose. To report on unusual findings in an EM study of a case of stromal micro-abscess in the equine cornea. Methods. A very small stromal abscess was removed from the cornea by deep lamellar keratoplasty. The sample was processed for an EM study. Results. Inclusion bodies were noted in two cases studied. Comparison with human corneal disease will be discussed. Conclusions. These findings establish the background for further studies. None.
Objective. To visualize the localization and macroscopic distribution of two different anesthetic fluid volumes to determine an appropriate volume for a single Sub-Tenon’s injection in equine eyes. Methods. A single Sub-Tenon’s injection of 2% lidocaine was performed in 10 equine cadaver heads (20 eyes) using two different volumes (7 ml on one side, 10 ml on the opposite side). The posterior migration and circular distribution of the anesthetic was assessed in sagittal, dorsal and transverse MRI (T2W-TSE) sequences and evaluated independently by three board-certified radiologists. Circular distribution was quantified and compared between the two groups using the paired Student’s t-test. The inter-observer reliability was assessed by use of a Kruskall Wallis Test. Results. In all injections the anesthetic expanded from the site of injection along the dorsal and the temporal quadrant into the intraconal retrobulbar space. Accumulation of anesthetic fluid directly surrounding the optic nerve was detected in 3 of 20 cadaver eyes including both test groups (2 eyes of the 7ml group, 1 eye of the 10ml group). Circular distribution of the anesthetic was not significantly different between groups. More retrograde leakage of the anesthetic was observed using the higher volume. Conclusions. The Sub-Tenon’s anesthesia has the potential as an alternative to a retrobulbar block in equine eyes. The appropriate technique, volume, cannula and injection site are crucial for the safety of the Sub-Tenon’s block. The distribution of the anesthetic solution, the clinical effects and the complications have to be evaluated in an in vivo study. Based on our results showing no significant difference and equally as good posterior intraconal distribution between the two chosen volumes this study suggest the lower volume of 7ml as being the most effective one. None.
THE EFFECTS OF OPTICAL DEFOCUS IN A 13 YEAR-OLD CONNEMARA PONY
(LD Kappler\(^1\), BM Fischer\(^1\), MG Davidson\(^2\), C Hall\(^3\), R Labens\(^4\), RJ McMullen Jr\(^1\)) 1 Equine Clinic Munich-Riem, Equine Ophthalmology Service, Munich, Germany; \(^2\) North Carolina State University, Department of Clinical Sciences, Raleigh, NC, USA; \(^3\) Nottingham Trent University, Brackenhurst Campus, Southwell, Nottinghamshire, UK; \(^4\) The Royal (Dick) School of Veterinary Studies, Easter Bush Campus, Midlothian, UK.

**Purpose.** To induce ametropia using corrective contact lenses in a 13-year-old Connemara pony gelding and evaluate the effects of optical defocus. **Methods.** Complete ophthalmic examination, including streak retinoscopy, confirmed that both eyes were within normal limits and net refraction was +0.25 diopters (D) OU. The pony was then evaluated while being longed (walk, trot and canter) and while navigating a small obstacle, followed by observation of the pony being lead through a simple obstacle course. Streak retinoscopy and observation of the pony during the previously described exercises was repeated eight times with the pony wearing one of five pairs of corrective lenses (Acrivet, S&V Technologies, Hennigsdorf, Germany). The lenses were masked (BMF) and randomly selected as matched or mixed pairs (-0.00D, -2.25D, -3.00D, -6.00D, and -9.00D, 36 mm diameter and a base curve of 20.0 mm) for a total of 9 evaluation stages. Each stage of the study was filmed by two observers (BMF, RJMJr). The videos were evaluated and graded by masked independent observers (CH, RL). **Results.** Ametropia ranged from -0.25D to +6.00D. Observational cues were identified regarding general behavior, ear movement, head carriage, movement and obstacle navigation. Alterations in ear movement, body tension, and deviations of normal behavior when approaching and navigating the obstacle were identified with variable severity depending on the degree of induced ametropia. **Conclusions.** Ametropia induced by corrective contact lens placement led to observable alterations in behavior and performance in the pony evaluated in this study. C.
Purpose. To determine the number of horses with ERU presenting to the Western College of Veterinary Medicine, and to describe and compare characteristics of ERU in the Appaloosa horse with other breeds. Methods. Horses diagnosed with ERU by a DACVO during the period of 2002-2016 were included. Eyes were classified as mild, moderate, or severe based on clinical manifestations. Breed, age, severity, final outcome, and causes of blindness were evaluated. Results. Thirty-two horses fit the criteria; 62.5% (20/32) were Appaloosas. Other breeds included 4 QH/QHX, 3 TB/TBX, 1 Miniature horse, 1 Percheron, 1 Hanovarian, and 2 Pony of America. Mean age at presentation was 11.7 years (4-23). ERU was bilateral in 30 and unilateral in 2 horses. ERU was severe, moderate, and mild in 23, 9, and 8 eyes of Appaloosas and 16, 4, and 2 eyes of other breeds. Twelve horses were blind OU at presentation and 20/26 were blind OU at last follow-up. Blindness was most commonly associated with cataract, glaucoma, and phthisis bulbi. Euthanasia was the final outcome in 17/26 horses. No significant differences in age, stage at presentation, blindness, or rate of euthanasia were noted between Appaloosas and other breeds. The proportion of ERU was significantly higher in the Appaloosa than in all breeds except the Pony of America and Hanovarian. Conclusions. ERU often presents in the severe stage in middle aged horses and leads to bilateral blindness with euthanasia a common final outcome. The Appaloosa, Pony of America, and Hanovarian are overrepresented for ERU. None
THE ROLE OF LEPTOSPIRA SPP. IN HORSES AFFECTED WITH RECURRENT UVEITIS IN THE UK (F Malalana¹, GL Pinchbeck², RJ Blundell¹, C McGowan³) School of Veterinary Science¹; Institute of Infection and Global Health²; Institute of Ageing and Chronic Disease³, University of Liverpool, UK

**Purpose.** Equine Recurrent Uveitis (ERU) is a common cause of ocular pain and blindness in horses. *Leptospira* has commonly been implicated in the pathophysiology of ERU in Europe and USA but no studies have been carried out in the UK looking specifically at ocular Leptospirosis. Serology alone is not useful in determining ocular antibody production; aqueous humour combined with serum titres may be more helpful: a positive C value (aqueous humour value / serum value) suggests intraocular antibody production. Aims of the study were to: 1) establish the prevalence of leptospiral ERU in the UK; 2) recognise the serovars involved in the UK and identify serovars not previously implicated; and 3) compare serum versus aqueous humour antibody levels in order to confirm the diagnosis of leptospiral uveitis. **Methods.** Ethical approval was obtained. Eyes from ERU-affected horses were collected. Blood and aqueous humour were obtained to determine antibody levels against a variety of *Leptospira* serovars and the C-value calculated. In addition, eyes, blood and aqueous humour were obtained from control cases for comparison. Histopathology was performed in all eyes to confirm the nature of each case. **Results.** 27 ERU eyes and 40 controls were analysed. Both populations were comparable with regards to age, sex and eye analysed. Of the ERU affected eyes, only 4 of these had a positive C-value (prevalence of leptospiral uveitis 14.8%). Serovars *hardjo*, *australis*, *javanica* and *hebdomanis*, not previously reported in ERU cases in the UK, were detected. A total of 17 out of 27 (63%, 95% CI 44-79%) uveitis affected horses were seropositive compared to 18 out of the 40 (45%, 95% CI 31-60%) controls. There was no statistical significance in seroprevalence between ERU and control cases (p 0.15), or amongst uveitis cases between those with leptospiral (C-value>1) compared to non-leptospiral (C-value ≤1) uveitis (p 0.26). **Conclusions.** *Leptospira* induced ERU is uncommon in the UK. Serology alone does not help diagnose leptospiral uveitis in the UK. Supported by PetPlan grant S14-63. None
TREATMENT OF RECURRENT UVEITIS IN HORSES WITH INTRAVITREAL LOW-DOSE GENTAMICIN INJECTION (BM Fischer¹, Brehm W², RJ McMullen Jr¹)¹Equine Clinic Munich-Riem, Graf-Lehndorff-Strasse 36, 81929 Munich, Germany; ²Chirurgische Tierklinik, Veterinärmedizinische Fakultät, Universität Leipzig, An den Tierkliniken 21, 04103 Leipzig, Germany

Purpose. Present initial and long-term results and report complications following low-dose Intravitreal gentamicin (4mg) injections in horses with uveitis. Methods. 92 eyes from 71 horses with various stages of uveitis and of various breeds, gender and age were treated. Intravitreal injections were performed using a 1ml insulin syringe with a swaged-on 12 mm, 30G needle 10 mm distal to the dorsal limbus, following sedation, local anesthesia, and conjunctival sac irrigation with 1% dilute iodine solution. Aqueous paracentesis was performed following Intravitreal gentamicin injection. Leptospiral antibody titers were evaluated from serum and aqueous humor and aqueous humor was screened for the presence of equine herpesvirus and leptospiral DNA. Results. Average follow-up was 124.9 (+/-149.4, range: 1-520 days). Transient complications (subconjunctival hemorrhage [22/92 eyes, 23.9%] and hyphema [3/92 eyes, 3.3%]) were observed in 25/92 eyes (27.2%). Permanent complications (cataract progression [4/92 eyes, 4.4%] and retinal degeneration [4/92 eyes, 4.4%]) were observed in 8/92 eyes (8.7%). Inflammation was controlled in 56/59 eyes from 47 horses with follow-up greater than 30 days. Vision remained stable or improved in 86/92 (93.5%) eyes. C-values for leptospiral antibody titers greater than 3 were identified in 13/83 (15.7%) eyes. EHV DNA was isolated in 35/83 (42.2%) eyes and leptospiral DNA in 25/83 (30.1%) eyes. Conclusions. Intravitreal injections of low-dose gentamicin eliminated active inflammation in the majority of horses in this study regardless of type, stage or severity of the uveitis present. Permanent complications were not observed when preservative-free gentamicin was utilized. None.
PHARMACOKINETICS OF ATROPINE IN THE HORSE (L Ström¹, C Johansson¹, C Ekstrand¹ & P Haubro-Andersen¹) Department of Clinical Sciences, Faculty of Veterinary Medicine and Animal Science, Swedish University of Agricultural Sciences, PO Box 7054, SE-750 07 Uppsala, Sweden¹

**Purpose.** To study the pharmacokinetic properties of ophthalmic atropine in the horse.

**Methods.** The study included six horses in a randomised cross-over design. All horses were administered a bolus dose of 1 mg of atropine intravenously (Atropin, 0.5 mg/mL, Mylan AB, Stockholm, Sweden), topically by manual administration (Isopto-Atropin, 1%, Alcon Nordic, Copenhagen, Denmark) and, using SPLs and infusion pumps, a CRI of 0.14 mg atropine per hour during 24 hours. There was a wash-out period of four weeks in between each treatment. Horses were monitored for signs of colic. Jugular blood samples were taken regularly. Plasma concentrations of atropine were determined by UPLC-MS/MS (detection limit 0.05 ng/mL). Pharmacokinetic parameters were determined by noncompartmental analysis.

**Results.** The bioavailability of atropine was 75 % (range 34-168 %). The median maximum plasma concentrations of atropine after intravenous injection was 0.83 ng/mL (range 0.68-1.33 ng/mL), after topical, manual administration 0.38 ng/mL (range 0.30-2.12 ng/mL) and after administration through infusion pumps 0.13 ng/mL (range 0.12-2.10 ng/mL). The terminal half-life of atropine was when administered intravenously 46 minutes (range 25-61) and when administered topically 59 minutes (range 36-95). No signs of colic were observed in any of the horses. 

**Conclusions.** The systemic bioavailability of 1% ophthalmic atropine was considerable. Large inter-individual differences were observed. Results indicate that 1 mg atropine in a dosage regime of 3-8 hours (median 5 hours) does not cause accumulation of atropine in plasma. Further studies are needed to study the effect on intestinal motility at different plasma concentration levels. 

**Declarations section Ethical Animal Research** Legal and ethical requirements have been met with regards to the humane treatment of animals described in the study. The regional Ethical Committee approved the use of the horses in this study. 

**Sources of Funding** University of SLU

**Competing interests** None.
Use of suprachoroidal injection of triamcinolone acetonide for treatment of non-responsive active uveitis

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Topic area:
Uvea

Case Summary (20-200 words):
Although intravitreal (IVT) injections of triamcinolone acetonide (TA) may be helpful for treatment of acute, non-infectious uveitis in horses, a high concentration of TA is found in the anterior chamber and cornea after these injections. As a result of the presence of the TA, we have observed a very frequent occurrence of infectious keratitis after IVT injections in horses that reside in the Southeastern US. Suprachoroidal space (SCS) injection of TA has been reported to as effective or better than IVT injection in acute uveitis and there is a negligible level of TA in the anterior segment of the eye after SCS injection. Therefore, we have injected TA into the SCS using microneedles in two horses with acute, non-infectious uveitis that were not responsive to topical or systemic therapy. The description of the SCS injection technique and clinical response of two horses will be discussed.

Key Words (5 or less):
Uveitis, triamcinolone, suprachoroidal space, complications

3-4 discussion points:
• Treatment options non-responsive uveitis?
• Have others observed corneal complications from IVT injections in horses?
• Availability of microneedles?

Pre-injection

Injection technique
Gaven, PJ; Hampson, ECGM; Dunn, K

Manly Road Veterinary Hospital, Manly, Qld; The University of Queensland, Gatton Qld; Focus Eye Pathology, QML, Murrarie, Qld; Australia.

**Topic area: Equine corneal epithelial inclusion cyst**

**Cornea**

**Case Summary (20-200 words):**
A 19-year-old Andalusian mare was presented with a large corneal lesion of the left eye that had gradually increased in size over the previous three years. Subsequent re-examination one year later revealed that the lesion had increased in size and it was becoming possibly uncomfortable. A keratectomy to remove the suspect corneal epithelial cyst was performed as a standing procedure using retrobulbar block and detomidine butorphanol CRI. The entire corneal surgical defect stained positive with fluorescein stain. Post operative medications were administered via a subpalpebral lavage tube and a corneal bandage lens was placed one week later. Histopathology revealed an intact corneal epithelial cyst with lobulated epithelial inclusions within an underlying stroma. Surgical excision was complete.

**Key words (5 or less):**
Cornea, inclusion cyst, standing keratectomy

**3-4 discussion points:**
Standing keratectomy or GA in horses?
Removal of entire cyst or superficial epithelium?
What are causes of corneal epithelial inclusion cysts in the horse?
Are they painful?

**2-3 photos, any common format, file size 500-2000k per photo:**

![Figure 1. Corneal lesion at time of surgery](image)

Figure 1. Corneal lesion at time of surgery
Figure 2. Corneal lesion at time of surgery

Figure 3. Histopathology of intact corneal lesion
Treatment of recurrent periocular squamous cell carcinoma in two horses

Case Summary:
Two geldings were surgically treated for periocular squamous cell carcinoma (SCC) in 2013. Blue, a grey piebald Cob gelding and Blaze, a chestnut Welsh Mountain cross pony live together with one other pony. In November 2012 Blue, an 18-year-old piebald Cob gelding was presented with a growth on the lid margin of lower eyelid. There was suspicious that it was a SCC as it readily took-up and retained Rose-bengal stain post rinsing with phenylephrine. A sliding graft (‘H’ plasty) was performed in January 2013 to remove the SCC and make up deficit. The tissue removed was diagnosed as SCC via histopathology. In April 2013 a lesion with the appearance of a SCC was identified in the medial canthus of the right eye of Blaze, an 18-year-old chestnut Welsh Mountain gelding. It was attached to the third eyelid (nictitating membrane). The nictitating membrane was removed and SSC was, again, diagnosed via histopathology. The surgeries were performed by Brian Patterson, BVM&S, CertVetOphth, MRCVS. Both horses recovered well but Blue showed signs of SCC on the lower lid of his left eye in the autumn/fall of 2013. SCC diagnosed by histopathology in April 2014. SCC occurred in the lower lid of his right eye, the site of the ‘H’ plasty in 2015. Blaze had a mass appear in the conjunctiva of the medial canthus of the right eye where the nictitating membrane had been removed. Surgery to remove the mass, within the conjunctiva of the lower lid of right eye, was performed in March 2015. SCC was confirmed. Rather than continue to perform surgery, the lesions in both horses have been reduced and controlled with oral meloxicam (Metacam, Boehringer Ingelheim Ltd) dose: 0.6 mg/kg body weight for approximately 10 – 14 days. Cryotherapy (Cryolfa pen) was performed on approximately 50 percent of recurrent bouts. Both horses are currently doing well.

Key Words:
Squamous cell carcinoma, recurrence, meloxicam, cryotherapy

Discussion Points:
Meloxicam as a form of chemotherapy?
Cryotherapy as an adjunct to chemotherapy with meloxicam or meloxicam on its own?
Figure 1 - Blue - lesion on lower right lid margin January 2013

Figure 2 - Blaze – lesion on nictitating membrane prior to removal April 2013

Figure 3 - Blaze - lesion in conjunctiva prior to removal March 2015
Multifocal and Rapidly Progressive Ocular Mast Cell Neoplasia in an Old Pony

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Topic area:
Cornea-sclera and adnexa

Case Summary:
A 26 year old Arab cross gelding with a history of Cushings disease, chronic laminitis and poor bodily condition presented with fluctuant swelling of the lower lid and ocular discharge of several weeks duration OS. On examination discrete pale fleshy masses were present on the dorsal corneosclera and within the nasal lower lid (Fig 1). Mast cell tumour(s) was suspected. Initial FNA and subsequent biopsy were reported as mixed mononuclear, predominantly eosinophilic, inflammatory reaction and fibrovascular granulation tissue with eosinophil infiltration respectively. No systemic disease was identified. Topical and intralesional steroids had no benefit. The masses OS rapidly enlarged. On day 13 proliferative fleshy masses were noted on the dorsal and dorsonasal sclera OD (Fig 2), and which subsequently extended rapidly towards contiguous limbus. On day 26 the gelding was euthanased on humane and economic grounds. The lesions OS comprised sheets of round cells with pleomorphic nuclei and finely granular eosinophilic cytoplasm which infiltrated the contiguous conjunctiva, episclera and subepithelial corneal stroma (Figs 3a and b & 4). Eosinophils were present throughout. Some round cells stained for Astra Blue and mast cell tryptase. Group consensus of several pathologists was probable mastocytoma involving immature cells.

Key words:
Multifocal, mastocytoma, immature cells.

Discussion Points:
Why the discrepancy in FNA and biopsy pathology reports and the ultimate diagnosis?
Why were the lesions rapidly progressive, and presumptively bilateral?
Was surgery ever an option (irrespective of the economic circumstances)?

Fig 1: Day 1- the corneoscleral mass OS, a mass is also present nasally in the lower lid
Fig 2: Day 13- the masses on the dorsal sclera OD

Fig 3a: The corneoscleral mass OS post mortem

Fig 3b: the lower lid mass OS post mortem

Fig 4: Histology of the corneoscleral mass OS (Stained H&E)
State of the Art Lecturer
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Josh Slater is a Professor of Equine Clinical Studies at the Royal Veterinary College. He is currently the head of the equine clinical group, and is the immediate past president of the British Equine Veterinary Association (BEVA). Josh graduated from Edinburgh Veterinary School in 1985. He spent 4 years in large animal and equine practice in the North of England before undertaking a residency in equine medicine at Cambridge Veterinary School. He completed a PhD in equine herpesvirus -1 in 1994 and became a lecturer, then senior lecturer, in equine medicine at Cambridge. In 2005 he moved to the Royal Veterinary College to take up post as Professor of Equine Clinical Studies and is head of the equine clinical group. He has active research interests (Pathogen Biology Research Group) in infectious respiratory diseases, especially the equine herpesviruses and Streptococcus equi, the cause of strangles.
Herpesviruses and Equine Ocular Disease
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Herpesviruses and ocular disease
Herpesviruses are ubiquitous across nature with all mammal species being infected by at least one herpesvirus. A universal feature of herpesvirus infections is their ability to establish persistent, often lifelong, latent infection in the clinically-recovered patient. Latency, in which recovered humans and animals carry virus in a quiescent (asymptomatic) form for extended periods, is central to the success of these viruses. Latently infected individuals act as asymptomatic reservoirs of infection with periodic reactivation of latent virus resulting in shedding of infectious virus and the potential to infect susceptible in-contact hosts and cause recurrent disease, including ocular disease, in the individual in which reactivation occurs. Herpesviruses are a common and important cause of ocular disease in humans and in several animal species including dogs, cats and cattle. There is accumulating evidence that the equid herpesviruses are also causes of ocular disease in horses and have been reported as occasional causes of ocular disease in camelids. The eye is an immune privileged site, an important immunological and anatomical adaptation that protects the eye from the damaging effects of inflammation. Whilst this is important in maintenance of normal ocular function and preservation of vision by suppressing potentially harmful inflammatory responses, in particular T cell responses, it also renders the eye more susceptible to infections that require a more robust cellular immune response for control and elimination. In the context of herpesvirus infections, therefore, the benefits normally associated with immune privilege become a disadvantage that may result in extensive virus-mediated destruction of ocular tissues.

In humans, the alpha herpesviruses Herpes Simplex Virus-1 (HSV-1) and Varicella Zoster Virus (VZV), the beta herpesvirus Cytomegalovirus (CMV) and the gamma herpesvirus Epstein-Barr Virus (EBV) have all been identified as causal agents of ocular disease in experimental models, in investigations of naturally-occurring cases of ocular disease and in epidemiological studies of ocular disease. HSV, VZV and CMV are the most common causes of human herpesvirus ocular disease and are associated with disease of all anatomical regions of the eye including epithelial, stromal and endothelial keratitis, uveitis and retinitis. HSV-1 is the principal ocular herpesvirus, accounting for 50-80% of all ocular herpetic infections. It mainly causes keratopathies and HSV keratopathy is one of the leading causes of blindness across the world. It is also associated with uveitis and is a rare cause of retinitis. The lytic phase of VZV infection (varicella or chickenpox) is principally associated with keratitis, whilst the reactivation phase (zoster or shingles) is associated with a range of ocular manifestations known as Herpes Zoster Ophthalmicus which can involve conjunctivitis, keratitis, uveitis, retinitis and optic neuritis. HSV and VZV keratitis is frequently characterised by punctate or dendritic keratitis, clinical findings that are considered characteristic of herpesvirus keratopathy. Whilst it is probably reasonable to extrapolate clinical observations like this to the horse, there is contradictory evidence about whether punctate keratitis in the horse is truly a herpesvirus disease or not.

Herpesvirus tropism
Herpesviruses are sophisticated pathogens with a large genome encoding a wide range of genes associated with host range, cellular tropism, virulence, immunosuppression and virus
replication. The equid herpesviruses, as with other herpesviruses that infect animals and humans, have complex life cycles adapted to exploit the host population and ensure virus persistence. Their life cycles involve infection of multiple cell types in different tissues, with different mechanisms for evasion of the host immune response. As a family, herpesviruses efficiently infect respiratory epithelial cells (the sites of initial virus replication), lymphoid lineage cells (establishing cell associated viraemia and latency), neuronal cells (causing neuropathology and allowing establishment of neural latency) and endothelial cell infection (allowing transfer of virus to and from the circulation and also causing thrombosis-ischaemia related vascular pathology). There is a spectrum of cellular tropism across the herpesvirus family from viruses which are principally neurotropic to those that are principally lymphotropic. Within the human herpesviruses, HSV and VZV are principally neurotropic; and CMV and EBV are principally lymphotropic viruses. Within the veterinary alphaherpesviruses there is also a spectrum of tropism with Suid Herpesvirus-1 (Pseudorabies virus), Bovine Herpes Virus-1, Feline Herpesvirus-1 being mainly neurotropic, and Marek’s disease virus being mainly lymphotropic. Equine herpesviruses -1 and 4 lie midway along this spectrum, being both neurotropic and lymphotropic during their life cycle.

Given the importance and prevalence of human herpesviruses as ocular pathogens, it is not surprising that several of the veterinary herpesviruses have been implicated as causes of ocular disease. BHV-1 and FHV-1 are both common causes of keratoconjunctivitis and SHV-1 virus is an efficient ocular pathogen in both experimental animal models and in natural infections, establishing recurrent keratitis analogous to that caused by HSV and VZV. For the principally neurotropic veterinary alphaherpesviruses the pathogenesis of keratitis and retinitis involves direct extension of infection from the conjunctival and corneal epithelium with neuronal latency established in trigeminal ganglia, periodically delivering virus back to the eye via the ophthalmic nerve to establish recurrent episodes of clinical infection. SHV-1 traffics efficiently in the nervous system with retrograde axonal transport from the trigeminal ganglia into the medulla to infect neurones throughout the CNS.

The equine herpesviruses
The equine herpesviruses (EHVs) are highly successful pathogens of all members of the Equidae family worldwide. Of the nine EHV's characterized thus far, five (EHV-1 to EHV-5) infect the domestic horse, and EHV-6 to EHV-9 are associated with infections in wild equids, including asses and zebra. The EHV’s are ubiquitous in both domestic and wild equid populations, and it is likely that the enduring success of the EHV as pathogens results from ancient co-evolution with the Equidae family and adaptation of the virus life cycle to ensure efficient spread within the equid population. The EHV's have a major economic and welfare impact on all sectors of the horse industry worldwide through their direct clinical effects on the horse, including respiratory disease, abortion and paralysis, and through their effects on the horse industry, including interference with horse movement for breeding and competition.

Pathogenesis of equine herpesvirus disease
The most extensively studied of the EHV’s are the alphaherpesviruses EHV-1 and EHV-4; as a result, the pathogenesis of EHV-1 disease syndromes, including ocular disease, has been reasonably well elucidated. The gamma herpesviruses EHV-2 and EHV-5 have received comparatively little study and, as a result, their role in ocular disease and other disease syndromes is less well understood. Following inhalation of virus or contact with infected fomites, the EHV's replicate in upper respiratory tract epithelial cells. Virus replication causes lysis of epithelial cells, resulting in epithelial erosions and respiratory tract-associated clinical signs. In EHV-1 infections virus quickly spreads to cells in the underlying lamina propria, with infected (viral antigen-expressing) endothelial cells, lymphocytes, and monocytes detectable in respiratory tract–associated lymph nodes within 48 hours. From these sites, virus-infected
lymphocytes enter the circulation, resulting in a mononuclear cell (principally CD8+ T lymphocyte–associated) viraemia that disseminates virus widely, including into the uterine and CNS vascular endothelium. Endothelial cell infection triggers vascular pathology resulting in thrombosis and ischaemic injury to the uterus and CNS causing the clinical syndromes of abortion and EHM. In parallel, EHV-1 also rapidly gains access to neurons of the trigeminal nerve, reaching the trigeminal ganglion by 48 hours after infection, establishing latency in trigeminal ganglionic neurons.

**Equine herpesviruses and keratoconjunctivitis**
The role of the EHV’s as causes of keratoconjunctivitis is controversial. The relatively small amount of research that has been carried out using experimental infections or studying naturally occurring cases of keratoconjunctivitis has failed to produce conclusive evidence of causality. Although EHV-1 can be isolated from conjunctival swabs after experimental respiratory tract infection and some animals develop conjunctivitis post infection, keratitis has not been observed after experimental infections and EHV-1 and EHV-1 DNA has not been detected in samples from clinical cases of keratoconjunctivitis. There has been more speculation about a possible causal role for the gamma herpesviruses EHV-2 and -5 in equine keratoconjunctivitis. Initial reports described keratoconjunctivitis following experimental infection of ponies with EHV-2 and the identification of EHV-2 DNA in conjunctival swabs from clinical cases of keratoconjunctivitis appeared to add further evidence of a possible causal role for this virus. However, subsequent studies have found that confirming causality for either EHV-2 or EHV-5 in cases of keratoconjunctivitis is confounded by the ubiquitous distribution of these viruses in the equine population and the fact that they are frequently isolated from normal horses without keratoconjunctivitis. Notwithstanding the absence of definitive virological evidence or of a characterised clinical syndrome, punctate keratopathies are regarded as likely herpesvirus lesions by some authors and treated empirically with antiviral drugs such as acyclovir.

**Equine herpesviruses and chorioretinopathy**
Chorioretinal disease following infection with EHV-1 was first described in llamas and alpacas and then in a mare and foal following a natural outbreak of paralytic EHV-1 infection. Subsequently, diffuse chorioretinopathy with blindness was observed in a specific pathogen free foal following experimental infection with EHV-1. Following this, a series of experimental infections of both specific pathogen free foals and naturally reared ponies, chorioretinal lesions were observed in approximately 30% of infected animals. Lesions included focal, multifocal chorioretinal lesions (Fig. 1) as well as diffuse lesions causing blindness (Fig. 2). Lesions appeared at variable time periods after infection, always towards the end or after the viraemic phase of infection, and were static once first detected ophthalmoscopically. In follow up experiments, fully pathogenic EHV-1 mutants carrying either the Lac-Z or GFP reporter genes were used to track the spread of virus to the eye after experimental infection. These experiments were able to track initial virus replication in the respiratory tract and subsequent spread into the circulation. Establishment of latency in the trigeminal ganglion was also demonstrated. There was no evidence of infection of neural tissues retrograde to the trigeminal ganglion sand no detection of virus in the brainstem (or any other regions of the brain) suggesting that spread via neuronal circuits as has been demonstrated for the HSV-1 and VZV, as well as SHV-1, was not involved in the pathogenesis of EHV-1 ocular disease. Temporally, EHV-1 was detected in choroidal vascular endothelium and the retina after the establishment of viraemia which, taken with the absence of evidence of virus spread through the CNS, suggested that the route by which EHV-1 reaches the eye is via the circulation. It is likely therefore that the pathogenesis of EHV-1 chorioretinopathy mirrors that of EHV-1 abortion and EHM and is a sequel of endothelial cell infection and vascular pathology causing local ischaemia. Fluorescein angiography of animals with multifocal lesions demonstrated
vascular attenuation in the region of lesions, adding further to the vascular hypothesis. EHV-1 chorioretinal lesions have been characterized histologically. Focal and multifocal lesions are characterized by a focal loss of retinal pigment epithelium with, usually with a central area of abnormal pigment accumulation, and loss of the directly overlying photoreceptor layer. The bipolar and ganglion cell layers of the retina are generally intact with the inference that although these lesions are likely to result in localized areas of vision loss, conduction of visual signals from radially distant regions of the retina is still likely to be intact and the impact of these lesions on visual function therefore limited (Fig. 3). The ophthalmoscopic and histological appearance of these lesions is consistent with the focal chorioretinal vasculopathies seen in humans and experimental animals following infarction after cardiovascular surgery or venous injection of microspheres. The diffuse chorioretinal lesions observed following EHV-1 infection are characterized by extensive degeneration and inflammation through all layers of the chiororetina and resemble the acute retinitis associated with the human herpesviruses. Naturally occurring multifocal and diffuse chorioretinal lesions have characterized histologically in abattoir studies: the lesions closely resemble those seen after experimental infection with EHV-1 and also contain EHV-1 DNA. Taken together, it is likely that EHV-1 is a cause of chorioretinal lesions and that these are vascular lesions occurring consequent to viraemic delivery of virus to the microcirculation in the eye.

**Figures.**

Fig 1. Multifocal EHV-1 chorioretinal lesions

![Fig 1](image1)

Fig 2. Diffuse EHV-1 chorioretinal lesions

![Fig 2](image2)
Fig 3. Histological appearance of focal EHV-1 chorioretinal lesions

Selected references


SATURDAY SESSION
ABSTRACTS & CASE REPORTS
NORMAL CONJUNCTIVAL MICROBIOTA IN HORSES. (EM Abarca$^{1,2}$, R Cuming$^1$, S LaFrentz$^3$, H Mohammed$^3$, C Arias$^3$) Department of Clinical Sciences, College of Veterinary Medicine, Auburn University, Auburn, AL, USA$^1$; Vetsuisse, Bern University, Switzerland$^2$; Department of Fisheries and Allied Aquacultures, Aquatic Microbiology Laboratory, Auburn University, Auburn, AL, USA$^3$.

**Purpose.** The equine conjunctival microbiota has often been reported to be dominated by Gram-positive species such as Staphylococcus sp., Bacillus spp. and Corynebacterium spp, however, traditional culture-based methods detect only a fraction of the microbiota. This pilot study aimed to explore the true diversity of the equine conjunctival microbiota using culture-independent DNA pyrosequencing. **Methods.** Conjunctival samples were collected from fifteen eyes (8 horses) from terminal laboratories performed at the JT Vaughan Large Animal Teaching Hospital, Auburn University, AL. Only horses with normal ophthalmic examinations were included. Biopsies of both conjunctival fornices were collected and DNA was extracted following standard protocols. The microbial diversity was determined by amplifying the variable V1-V3 region of the 16S rRNA genes. Amplicons were then subjected to Roche 454 FLX titanium sequencing. Operational taxonomic units (OTUs) were taxonomically assigned using BLASTn against the Greengenes database. Species richness, evenness, and Good’s coverage were determined. **Results.** The total number of reads was 170,821 while the number of bacterial OTUs assigned to these reads was 332. The top three species in relation to number of reads were Ralstonia mannitolilytica (87.26%), Nicoletella semolina (3.23%) and Pseudomonas tolaasii (1.47%). The number of reads was normalized to 5,608 for generating species richness, evenness and Good’s coverage. **Conclusions.** This is the first study in which the microbial community present in healthy equine conjunctiva was examined using next generation DNA sequencing technology. Contrary to previously published data based on culture-dependent methods, the microbial communities were dominated by Gram-negative bacteria of the phylum proteobacteria. **None.**
THREE CASES OF EOSINOPHILIC GRANULOMATOUS CONJUNCTIVITIS IN THE NETHERLANDS (H Hermans, N Verhaar, TJP Spoormakers and JM Ensink). Department of Equine Sciences, Faculty of Veterinary Medicine, Utrecht University, The Netherlands.

**Purpose.** To describe the occurrence of 3 cases of eosinophilic granulomatous conjunctivitis in the Netherlands, most likely caused by the infection with nematode larvae, also known as ocular habronemiasis. To the author’s knowledge ocular habronemiasis has not been documented previously in the Netherlands. **Methods.** Retrospective study. Case description based on data from the medical records of the equine hospital facility. **Results.** In the summer of 2015 two separate cases were presented at the equine hospital with complaints of a non-resolving conjunctivitis of the medial canthus. When reviewing the patient records, one other similar case was found which occurred in July 2001. The diagnosis was made on the basis of history, clinical signs including the presence of sulphur-like granules and histologic examination of biopsy specimens. In all three cases the histopathological examination yielded a severe chronic eosinophilic granulomatous conjunctivitis, which is consistent with the diagnosis of habronemiasis. Nematode larvae were seen in one of the biopsy specimens. In all three cases the treatment consisted of systemic ivermectin or moxidectin. Furthermore treatment combinations of surgical excision, topical levamisole solution, and triamcinolone-acetonide sub-conjunctivally were used. **Outcome.** Treatment provided healing of the conjunctivitis in all three cases and there was no recurrence of the condition long-term. **Conclusions.** The results suggest that the diagnosis of ocular habronemiasis should be considered in the temperate oceanic climate of Western Europe when being presented with a horse with a granulomatous conjunctivitis, especially during the summer months. **None.**
DEVELOPMENT OF AN EX VIVO EQUINE CORNEAL MODEL (EA Giuliano 1, TL Marlo 1, A Sharma 1,2, RR Mohan 1,2,3) Department of Veterinary Medicine and Surgery, College of Veterinary Medicine, University of Missouri, Columbia, Missouri; 1 Harry S. Truman Memorial Veterans Hospital, Columbia, Missouri; 2 Mason Eye Institute, School of Medicine, University of Missouri, Columbia, Missouri.3

Purpose. To determine if the equine cornea is suitable as an ex vivo model. Specifically, to assess the equine cornea's extracellular matrix and cellularity using two different culture techniques (either (a) an air/liquid interface or (b) immersion system) to determine the best ex vivo equine corneal model. Methods. Equine corneas with 2 mm of perilimbal sclera (n=14) are freshly harvested from horses undergoing humane euthanasia. One scleral-corneal ring (SCR) from each horse is randomly placed in the (a) air/liquid interface organ culture system (ALC), with the contralateral SCR being placed in the (b) immersion condition (IC) organ culture system for 7 days. All SCRs are evaluated using serial daily gross photography, histology, RT-PCR and TUNEL assay. Results. SCR's placed in b (IC) had complete loss of corneal transparency on gross photography by 7 days, showed a significant level (p<0.05) of stromal disorganization, and significantly increased (p<0.05) αSMA levels on RT-PCR and apoptosis on TUNEL assay when compared to controls. System a (ALC) had weak stromal disorganization on histopathologic examination and was not significantly different from normal equine corneal controls on any other evaluated parameter therefore proving our hypothesis. Conclusions. The ALC condition (a) maintains the equine cornea's cellular extracellular matrix and preserves corneal transparency, while the IC system (b) results in near complete degradation of the normal equine corneal architecture after 7 days in culture. The air/liquid interface system is a viable option to maintain a normal equine cornea in an ex-vivo setting for future planned studies. None.
IMPRESSION CYTOLOGY AS DIAGNOSTIC TOOL IN HORSES WITH AND WITHOUT OCULAR SURFACE DISEASE (BK Braus,1 B Lehenauer1, A Tichy2, B Nell1 and I Schwendenwein3) 1Department for companion animals and horses, University of Veterinary Medicine, Vienna; 2Department of Biomedical Sciences, University of Veterinary Medicine, Vienna; 3 Clinical Pathology Platform, University of Veterinary Medicine, Vienna

**Purpose.** To compare irritation for the patient, invasiveness, sample quality and diagnostic equivalence between two sampling methods for obtaining corneal and conjunctival cell samples. **Methods.** Conjunctival and corneal samples were taken bilaterally in five healthy horses with ICS (impression cytology sampling) and CBS (cytobrush sampling). Irritation was graded with an eye irritation scheme based on subjective assessment of possible aversive reactions during the sampling procedure and invasiveness was graded with an epithelial damaging score system based on the size and type of the lesion following fluoresceine staining. Sample quality was evaluated via morphometric analysis and graded by a board certified clinical pathologist (part I). For the assessment of diagnostic equivalence, 15 eyes of 14 client owned horses with ocular surface anomalies were sampled by ICS and CBS (part II). Both methods were compared regarding the types of inflammatory cells and/or infectious agents detected. The resulting cytological diagnoses were compared to the histopathological diagnosis when available. **Results.** ICS was significantly less invasive and less irritating for the horses. Both methods retrieved cells of overall high quality; the cell quantity was however significantly higher in IC samples. ICS preserved the natural cellular layout. There was no statistically significant difference between the diagnostic outcomes (ICS vs. CBS) in diseased horses although CBS resulted in a slightly greater variability of inflammatory cell types. **Conclusions.** ICS is a non-irritating, non-invasive method to obtain high quality cytology samples enabling the evaluation of healthy and diseased equine ocular surfaces. ICS can be recommended for cell sampling in delicate corneas. ICS is especially useful in cases where preservation of cellular layout is advantageous. **Funding.** None **Conflicts of interest.** None
PROCEDURE. To describe the use and value of spectral domain optical coherence tomography (SD-OCT) in clinical cases of corneal disease in horses. Methods. Retrospective study. Handheld SD-OCT (Envisu, Bioptigen, Inc., Morrisville, NC) was used for high resolution imaging of horses with corneal disease presenting to the NCSU Equine Ophthalmology Service from 2013-2015. Results. Thirteen horses were included in this study, including 7 horses with stromal abscesses (SA), 3 with neoplasms, and 3 with immune-mediated keratitis (IMMK). Excellent high-resolution images of the cornea were obtained using hand held SD-OCT in standing or anesthetized horses, however, acquiring images was time-consuming due to the inherent movement of the examiner and horse. Despite this, in horses with SA, SD-OCT assisted with determining location of the abscess in the cornea and if penetration of Descemet’s membrane was present. In 2 of 7 horses, fungal hyphae were also visible within the abscess. In horses with neoplasia, the SD-OCT helped to determine if the cornea had neoplastic invasion (melanoma n=2) and the depth of penetration into the stroma (SCC). With IMMK, depth of corneal stromal involvement (e.g., superficial, mid stromal, endothelial) could be determined. Conclusions. Results from this retrospective study suggest that hand-held SD-OCT for imaging the cornea of horses is feasible and may be helpful in accurately determining depth and extent of lesion in the cornea. None.
Purpose. To record topographical information from equine corneas presented with linear band opacities. Methods. 16 eyes from 13 horses were presented with linear band opacities between 2012 and 2015. The eyes were periodically measured using a corneal topography machine (Keratron Scout). Repeatability assessment was performed following acquisition of 8 scans from each cornea, and measurements only recorded if the Best Fit Sphere of at least 5 processed maps were within 0.20D of each other. Results. The mean (±SD) values recorded at presentation were: corneal curvature 20.59D (0.81), astigmatic error 0.84D (0.52). Keratoconus was identified in one eye at presentation and developed in two eyes during periodic reassessment. Cone location and magnitude indices algorithms were applied to each case and all had a percent probability of keratoconus >98.4%. The mean (±SD) magnitude of keratoconus at detection within a 2mm diameter zone around the apex was 31.4D (5.94), the maximum apical curvature detected was 93.18D, and the mean total diameter was 13.33mm (5.75). Conclusions. Corneal topographical analysis may be a useful tool to identify keratoconus in equine cases presented with linear band opacities. To the authors' knowledge this is the first report of keratoconus development in the equine cornea.
Purpose. Describe the technique of intrastromal indocyanine green (EmunDo®, A.R.C., Nürnberg, Germany) photothermal therapy (PTT) and preliminary results following treatment of immune-mediated keratitis (IMMK) in the horse. Methods. 14 eyes from 13 horses with various forms of IMMK were treated under standing sedation and retrobulbar anesthesia. Following conjunctival sac irrigation with 1% povidone iodine and topical anesthesia, multiple intrastomal injections of EmunDo® using a 12 mm, 30G insulin syringe were carried out. Infrared digital images confirmed confluency of the EmunDo® over the affected cornea. An 810nm Fox Diode laser (A.R.C., Nürnberg, Germany) was utilized to activate the intrastomal EmunDo® at 500mW for 30s intervals (range: 6-8 per 25% corneal surface; target goal: 60-75J per quarter cornea). Post-PTT treatment consisted of topical antibiotics (7d), and topical (4-6 weeks) and systemic NSAIDs (7-10d, 1.1 mg/kg, p.o.). Results. Multiple intrastomal injections were necessary to achieve confluency of EmunDo®, confirmed by direct visualization and infrared digital photography. Transient complications included intracameral application of EmunDo® and superficial corneal ulceration that healed within 7 days in 4/14 eyes (28.6%). Secondary bacterial corneal infection requiring prolonged antimicrobial therapy and conjunctival grafting and persistent corneal inflammation occurred in one horse each. To date, medical therapy has been discontinued without subsequent recurrences in 6/14 horses (range 6 weeks to 7 months). Dark green corneal discoloration remained visible for up to 3 months. Conclusions. Intrastromal PTT with EmunDo® can be safely and effectively utilized to treat IMMK in the horse. Long-term follow-up and further investigation are necessary. None.
Case Summary
An 18-year-old Thoroughbred mare was presented for persistent right ocular irritation over a one-month period. Slit lamp biomicroscopy revealed non-ulcerative multifocal punctate keratopathy of the right cornea. No evidence of other ophthalmological disease could be found. Equine herpes virus (EHV) testing did not yield a positive result. Treatment with topical cyclosporine 0.2% was commenced and improved ocular comfort and a reduction in the number of punctate lesions were observed.

Corneal topography was performed before and after therapy with a portable videokeratoscope. Multiple irregularities of corneal curvature were identified prior to therapy, which were not evident following treatment.

Key words
Cornea, keratopathy, keratometry, topography

Discussion points:
Disturbance of vision with a non-ulcerative multifocal keratopathy
The use of corneal topography in equine ophthalmology
Reliability of ophthalmic instruments designed for the human eye

Images: (see next page)
C Dixon Case Report Photo 1: The right eye at presentation with

C Dixon Case Report Photo 2: Topographical analysis of the right cornea at presentation. Multiple irregularities of corneal curvature were detected.

C Dixon Case Report Photo 3: Topographical analysis of the right cornea following medical management of the disease. The cornea had a more uniform curvature.
Primary corneal malignant melanoma in a Missouri Fox Trotter

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Topic area:
Cornea

Case summary:
A 13-year-old Missouri Fox Trotter gelding presented with multiple pale pink fleshy corneal masses OS (Figure 1). Cytology was suspicious for squamous cell carcinoma but superficial biopsy was nondiagnostic and did not support SCC so surgical keratectomy ensued. Lamellar keratectomy was performed to remove the corneal lesions and adjunctive strontium-90 therapy was applied. A-cell grafts were sutured into the defects to facilitate healing. Corneal histopathology was suggestive of a poorly-melanized malignant melanoma within and adjacent to the corneal epithelium. Immunohistochemistry was most consistent with a malignant melanoma. Once the surgery sites were adequately healing 19 days postoperatively mitomycin C 0.04% was instituted at QID for one week then off one week and repeating for a total of 4 cycles. Slightly elevated white corneal lesions occurred in the previous excision sites 3 weeks after starting mitomycin treatment, 6 weeks postoperatively (Figure 2). Topical neomycin/polymyxin B/dexamethasone was instituted QID and resolution was noted within 4 weeks to support inflammatory tissue occurrence. No evidence of corneal cancer regrowth or metastatic disease has occurred 4 months following surgery. Mild eyelid alopecia OS first noted 2.5 months postoperatively (Figure 3) has progressed to more extensive eyelid alopecia and depigmentation despite cessation of topical therapy.

Key words:
Corneal melanoma, mitomycin C, eyelid alopecia and depigmentation

Discussion points:
1. Other known cases of primary corneal malignant melanoma?
2. Preferred regimen for mitomycin C?
3. Mitomycin C as the cause of skin depigmentation and alopecia? Other thoughts on eyelid changes?

Images:
Clinical appearance of the patient’s right eye during sequential hospital visits
Figure 1. Image of the 13 year old Missouri Fox Trotter gelding at initial presentation with raised pale pink corneal lesions visible in the dorsal cornea.

Figure 2. Image of the same horse 6 weeks postoperatively and 3 weeks after starting mitomycin C therapy when slightly raised white inflammatory lesions were noted.

Figure 3. Image of the same horse 11 weeks postoperatively with improved corneal status and mild ventromedial eyelid changes first observed.