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Veterinary Ophthalmology is a peer-reviewed, international journal that welcomes submission of manuscripts directed towards academic researchers of veterinary ophthalmology, specialists and general practitioners with a strong ophthalmology interest. Articles include those relating to all aspects of:

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- Experimental models of both animal and human ocular disease in veterinary species
- Anatomic studies of the animal eye
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Membership information

Full membership is open to veterinary surgeons with an interest in the field of ophthalmology. Associate membership is open to those with a professional interest in the field of ophthalmology. Membership is for 12 months and starts on 1st April. Membership fees are 40 per year.

Abstracts / lecture notes submission

Please follow the guidelines below:
- The first line should give the title.
- The authors’ names should appear on the next line - initials followed by last name.
- Provide the name of your practice / institution.
- Use single spacing.
- Use 10 point Trebuchet MS font for all text.
- Photographs or diagrams are encouraged, but do not place them within the main body text. Instead send each photograph or diagram as a separate JPEG image with a title such as “Figure 1: The eye before surgery”. Up to four images may be included. If additional images are required, please discuss this in advance of the deadline.
- The abstract should be 500-1000 words.
- Please send in electronic format to natasha@eyevet.ie.

Deadlines

Deadlines will be published on the website but are usually the first day of the month, two months prior to the meeting. Abstracts will be reviewed and the author notified one week after the submission deadline with time allowed for alterations if required.

Twelve minutes will be allocated for each presentation, with a further three minutes for discussion. All oral presentations must be made in English. Presentations must be compatible with Microsoft Powerpoint 2003.

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Dear Delegates,

We wish to extend you a very warm welcome to our BrAVO Spring meeting. This year we are delighted to have been able to run our meeting alongside the annual ECVO conference. It is a great opportunity for our European colleagues to join us in our learning, and we will all benefit from getting to know each other in the lovely surroundings of the Queen Elizabeth II Conference Centre. We hope that we will be able to share lively and informative discussion, both during the meeting and during the breaks. The meeting program has been designed to complement the surgical theme of the ECVO conference. Our focus will be cataract surgery and the morning session is entitled: ‘Phacoemulsification: A Step by Step Dissection’. The invited speakers Heidi Featherstone and Christine Heinrich hope to address the questions that might have been in the mind of those doing phacoemulsification and open a discussion with audience involvement. The second half of the day welcomes the return of Brian Little to present complications of cataract surgery in humans. An entertaining speaker, Brian will discuss why complications occur and how to minimize them before moving on to discuss vitreal loss.

Refreshments will be provided during the breaks, and there will be a ninety-minute break for lunch. Our sponsors are providing a commercial exhibition, which is a vital part of the day’s events. We encourage you to visit the various stands, and avail of the opportunity to explore current ophthalmic equipment and supplies, while catching up with friends and colleagues.

BrAVO also run a weekend Winter meeting annually, and this year it will take place in Birmingham from 14-16th November 2014. The theme this year is neuro-ophthalmology, and the main speaker is Jacques Penderis BVSc MVM PhD CertVR Dip ECVN MRCVS, an expert in the field of neurology. More information is available on our website, www.bravo.org.uk. The website also has more information about the association and member benefits including the recently launched Facebook discussion group, book discounts and travel scholarships.

Finally we would like to thank you for attending the meeting and hope that you have an educational and rewarding day.

With best wishes,

The BrAVO Committee
SPEAKERS BIOGRAPHIES

Christine Heinrich

DVOphthalmal DipECVO MRCVS

RCVS and European Specialist in Veterinary Ophthalmology

Christine received her degree in 1995 from Munich Veterinary School in Germany. She then moved to the UK where she first completed an Internship followed by a Residency in Comparative Veterinary Ophthalmology at the Animal Health Trust in Newmarket. Christine holds both the Royal College of Veterinary Surgeons (RCVS) and the European College of Veterinary Surgeons (ECVO) Diplomas in Veterinary Ophthalmology and has been an RCVS Specialist in her discipline since 2001. Christine is dedicated to the teaching of Veterinary Ophthalmology to postgraduate veterinary surgeons and together with her colleagues at Willows Referral Service she mentors ECVO residency programmes at the Willows. Christine also loves teaching veterinary ophthalmology to general practitioners, and she has lectured widely not only in the UK but also internationally. In the last few years, Christine has especially enjoyed being involved in teaching feline ophthalmology under the growing awareness that ‘cats are not small dogs’ - and she has especially been very honoured to have participated as a speaker in several meetings organised by the International Society for Feline Medicine and Surgery (ISFM).

Heidi Featherstone

BVetMed DVOphthalmal DipECVO MRCVS

RCVS and European Specialist in Veterinary Ophthalmology

Heidi graduated from the Royal Veterinary College, London in 1991 and worked in general practice in the UK and Hong Kong for seven years, prior to starting a residency in ophthalmology at the Animal Health Trust in 1998. Heidi now works at Willows Referral Service, West Midlands, where she is part of an ophthalmology team with a busy medical and surgical caseload. She was involved in BrAVO work for many years and is now the secretary of the European College of Veterinary Ophthalmologists. Heidi is actively involved in resident training and is a visiting lecturer at the Nottingham Veterinary School. Her main interests are corneal and intraocular surgery.
Brian Little
MA, DO, FRCS, FRCOphth, FHEA

After gaining a first class degree in Physiology, Mr Little qualified at Cambridge University with a distinction in surgery in 1983. He then underwent specialist training in ophthalmology at Oxford, St Thomas’s and Moorfields Eye Hospital. His particular interests are cataract surgery and glaucoma. He is a consultant at Moorfields Eye Hospital, where he is responsible for running their training programme in cataract surgery. He has been performing phacoemulsification for over 20 years and he has a particular interest in complex cataract surgery. He runs training courses in cataract surgery in the UK, Europe and the USA and in 2009 was appointed as the International Member of the Cataract Clinical Committee of the American Society of Cataract & Refractive Surgeons. He was also elected to the International Intraocular Implant Club (250 members globally) in recognition of his contribution to the development of cataract surgery. He is a Principal UK Expert on the International Working Group of the IEC/BSi that develops global standards for ophthalmic surgical equipment. In 2006 he was elected Fellow of the Higher Education Academy. He currently sits on the Council of the UK & Ireland Society of Cataract & Refractive Surgeons. He is a regular invited speaker at national and international meetings and in 2009 he received the International Ophthalmologist Education Award from the American Academy of Ophthalmology. In 2010 he was Visiting Professor in New Zealand and delivered a lecture tour encompassing their principle ophthalmology departments. In 2010 he was listed by The Times as one of the five top ophthalmologists in Great Britain. In 2012 he received the Gold Medal award of the Intraocular Implant and Refractive Society of India and an Exceptional Service Award, Gold Medal in Ophthalmology from the International Academy for Advances in Ophthalmology. In 2011 he was Visiting Professor in Iowa where he delivered the prestigious Wolfe Foundation Lecture, the first UK ophthalmologist to do so in its 42-year history. He is active in the Royal College of Ophthalmologists as a member of their Information Technology Committee, Microsurgical Training Sub-Committee, e-learning Committee and the Quality and Safety Committee.

Mr Little is involved in clinical research and has published over 50 articles in peer-reviewed journals as well as authored numerous chapters and contributed to major textbooks. He is Series Editor of the award-winning Video Atlas of Eye Surgery whose material is licensed to the American Academy of Ophthalmology and used by over half the trainee ophthalmologists in the USA (www.eyemovies.co.uk). He has worked for ORBIS, the international eye charity, for over 10 years has been an active member of their Volunteer Faculty training eye surgeons in developing countries. He is also one of their UK Ambassadors, in which capacity he promotes ORBIS in the UK and Europe. He was elected a Member of the Guild of Master Craftsmen for his cabinet making skills and is a keen motorcyclist. In 1985 he built his own aluminium-bodied convertible classic sports car that was used in a TV series. He lives in north London and is married to Kate, his eternally tolerant GP wife. They have three grown up children who generally find them both an embarrassment.
Many excellent books have been written to teach phacoemulsification in humans and these will give invaluable information and help for the ‘budding’ veterinary cataract surgeon. Remarkably, publications about techniques and tips for canine cataract surgery remain sparse (Nasisse, 1997, Warren, 2004, Wilkie, 2013, Wilkie and Colitz, 2013). The authors of these notes therefore hope to share some of the knowledge that they have gained by experience - being fully aware that the presented information is largely subjective and born out of the ‘trial and error’ of many years of performing cataract surgery. Neither of the authors claims to be a ‘hot-shot’ surgeon - but both have learnt that minor aspects of surgery such as the right positioning of the eye, the use of precise and well-cared for instruments and the appropriate choice of medical treatment may be crucial in deciding whether a surgery will be uncomplicated or whether it will be fraught with complications. To name an example - the use of a re-sterilised, slightly blunt phaco knife to create the corneal incision may result in a slightly oblique wound with a small conjunctival incision. During phacoemulsification, irrigation fluid escaping the wound will collect under the conjunctiva and result in conjunctival ballooning - which can become so severe that visualisation of the intraocular structures becomes impaired. As a result, an inadvertent trauma to the posterior lens capsule can result in a large posterior tear with catastrophic loss of the nucleus into the posterior segment. Following vitrectomy and retrieval of the cataract material, it then may become apparent that capsular support for IOL implantation is now lacking and the eye has to be left aphacic. As a result of the posterior segment disturbance, retinal detachment ensues 6 weeks post-operatively. And the one, small thing that has set all this in motion was the poor decision to use a blunt phaco-lance - and the failure to recognise the conjunctival wound and react by closing the initial incision and performing a new one with a sharp knife. If one thing should stand out from these notes, it is that attention to detail is the overriding rule in canine phacoemulsification.

**Equipment requirements**

Phacoemulsification is an elective procedure and there is thus no excuse to embark on it without adequate equipment - including the surgical instruments, phacoemulsification equipment and microscope. In addition, muscle relaxant anaesthesia remains the ‘gold
standard’ for this procedure in small animal veterinary ophthalmology and certain equipment is required for monitoring (see under anaesthesia). But what is as important as the mechanical equipment is the team that operates it and cares for it - your nurses, anaesthetists and yourself!

Surgical instruments

Instruments for intraocular surgery should be of high quality and should be treated with a certain measure of ‘respect’ by every member of the team. Storage of these instruments should be in boxes with silicone-pads which contain ‘nipples’ to stop slipping of the individual instruments or contact during sterilisation. Laminated photographic cards showing the instruments belonging into each pack are helpful (Fig.1). Specific instructions for the cleaning and sterilisation of instruments should be obtained from the manufacturer and followed. If suitable for the type of instruments, ethylene oxide sterilisation is always preferable to autoclaving with steam. Specific steps to enhance the life-span of these microsurgical instruments include ensuring that every member of the team that comes into contact with them knows their identity and intended use.

Certain ‘types’ of instruments will be required for certain steps of the phacoemulsification procedure but the final decision, which variation of a certain instrument to use will be surgeon specific. Below, a choice of re-usable instruments which the authors like to have available for phacoemulsification, is given. Various disposable instruments will also be required depending on the type of phacoemulsification equipment used (corneal incision knives, drapes etc). It is possible, to buy these disposables specifically prepared in a single sterile pack according to individual requirements - which saves a significant amount of time and organisation in the set up for the procedure.

**LIST OF INSTRUMENTS:**

- St Martin's Tying Forceps 0.15 mm teeth
- St Martin's Tying Forceps 0.3 mm teeth
- Castroviejo Tying Forceps 0.12 mm forward facing teeth
- Pearce Capsulorhexis forceps (titanium)
- Utrata Capsulorhexis forceps (titanium)
- Kratz Barraquer Speculum (with one crossbar only) fixed
- Kratz Barraquer speculum (with one crossbar only) with sliding mechanism
- Castroviejo Curved Needle Holders - no catch
- Weiss or Troutman Curved Micro Needle Holders - no catch
- Kelman Mcpherson Lens Folding Forceps
• Vannas Scissors 12 mm blade length
• Castroviejo Corneal Scissors
• Straight Iris Scissors - sharp tip
• Curved Blunt Excision Scissors
• Lens Manipulator - Titanium
• Number 3 Scalpel Blade Handle
• Beaver blade handle Halstead
• Curved Mosquito Haemostats x2
• Halstead Straight Mosquito Haemostats x2
• Smooth Non Gauze Swabs On Bottom Tray x4
• Backhaus Towel Clamps x4

Microscope

When choosing an operating microscope, the following questions should be considered:

• Used or new - consider whether the need for ‘same day support’ for technical problems can be met for used models
• Foot or ceiling mounted - the latter reserve space in small theatres but are often more expensive and less flexible

• Absolute requirement:
  o High quality optics with 5-30x magnification
  o Individual adjustment of dioptre and interpupillary distance of surgeon
  o Foot pedal with focus, zoom and X-Y axis control
  o Working distance: 15-20 cm (this can be changed between surgeons with exchange of a lens)
  o Sterile covers for handles

Phaco machine

Buying a used phaco machine may be an initially attractive option - however, do consider that you may find problems sourcing disposables (such as the phacoemulsification pack) or replacement parts (phacoemulsification handpieces have a very limited life-span). Furthermore, technical support for maintenance of used machines may no longer be available and it might thus be ‘false economy’ to buy a used model. The basic decision, which model to choose will not only be based on the price but on the technique the machine uses. Generally, models are divided based upon their mode of operation into ‘venturi’ or ‘peristaltic’.
To understand the difference between the two modes, the basic concept of phacoemulsification must be considered. In phacoemulsification, pieces of cataract are emulsified after being drawn towards the tip of the phaco tip. The suction required to draw a piece of lens material towards the phaco tip is created via extraction of fluid from the inflated eye through the aspiration line. The amount of fluid aspirated from the eye is varied for different stages of the procedure and is referred to as ‘aspiration flow rate’ (AFR). Fluid removed from the eye with aspiration is constantly being replaced with irrigating solution, which flushes into the eye via an infusion line that is connected via a plastic sleeve placed around the tip of the phaco handpiece. Once a piece of cataract is engaged into the phaco tip, it is emulsified with ultrasonic power and removed from the eye via the aspiration tubing. To secure a piece of cataract to the tip, it needs to be fixed in place by vacuum. Those machines using ‘peristaltic’ technology build up a vacuum (to a pre-set level) at the tip of the phacoemulsification needle only if it is occluded. This suggests that the machines are ‘safer’ for beginners as theoretically less risk exists that inappropriate structures (such as iris or posterior lens capsule) are ‘sucked’ quickly into the phacoemulsification tip. Venturi-based machines work with a compressor and build up vacuum immediately (to a pre-set level) in a linear fashion dependent on foot-pedal control. They are often believed to be ‘more reactive’ and ‘powerful’ but are thought to have an inherent higher risk that structures such as the posterior lens capsule or iris could be inadvertently aspirated and are thus not suggested for beginners. Venturi machines require an internal compressor or an attachment to an air supply. If later progression to posterior segment surgery (retinal re-attachment surgery) is intended, machines with Venturi mode should be chosen as these can usually be upgraded for this purpose with additional modules. Overall, with advancing technology, the ‘waters between’ the two modes of operation have become ‘muddied’ and newer peristaltic machines are extremely responsive. Furthermore, it is possible to change between modes on some models of phacoemulsification machine. Finally, most surgeons simply prefer the type of machine that they have become accustomed to.

‘Surge’ is the phenomenon that occurs when a piece of cataract material, which has occluded the tip, passes through. Given that potentially high vacuum had been built up to suck the occluding piece through the tip into the tubing, aqueous or irrigating fluid will follow the cataract material rapidly, which can result in shallowing of the anterior chamber and anteriorisation of the posterior lens capsule - predisposing to capsular tears. Using high aspiration flow rates and high vacuum levels are risk factors for surge. Modern phacoemulsification machines have multiple ways to counteract surge - including stable tubing, automatic bottle height adjustment and excellent venting facilities. A flared tip will usually be required for machines in Venturi mode as this helps to reduce the risk of surge. In addition, using low aspiration flow rates and low vacuum during removal of the last cataract fragments minimises the risk of surge-related complications.
Peri-operative medication

The aims of peri-operative medication include the following:

- Minimising uveitis
  - Pre-existing uveitis should be pre-treated, ideally phacoemulsification should be carried out on a ‘quiet’ eye
    - If uveitis subtle: Ketorolac 3x daily
    - If marked uveitis: Prednisolone acetate up to 6x daily
    - +/- systemic NSAIDs
  - Exceptions include: rapid onset cataracts with risk of spontaneous capsule rupture (such as diabetic cataracts or cataracts in young patients) as well as traumatic cataracts - here urgent surgical intervention following a minimal time of intensive treatment may be required to prevent serious complications
    - Clinically, the authors have had very positive experiences with the use of oral cyclosporine to manage severe cases of pre-existing lens-induced uveitis in the peri-operative time. However, the effect of this has not been reported in peer-reviewed publications
  - Immediately pre-operatively, for the management of surgically induced uveitis, topical NSAIDs appear as, if not more efficient than topical steroids (Giuliano 2004)
    - Ketorolac 0.5 and Flurbiprofen 0.03% q 30 minutes for two hours pre-operatively
    - Additional systemic NSAID’s (Carprofen, Meloxicam)

- Induce and maintain mydriasis
  - 1-2 applications of a short-acting mydriatic/cycloplegic (tropicamide) 30 and 60 minutes pre-operatively
  - Atropine rarely required
  - The concurrent use of a topical NSAID’s aids maintaining mydriasis by preventing prostaglandin-induced miosis (which is independent from cholinergic miosis!)

- Irrigation fluids for phacoemulsification/irrigation-aspiration
  - Specific balanced salt solutions (BSS) have been developed to prevent damage to the corneal endothelium and other intraocular structures during phacoemulsification
- BSS/Acripur: adequate amount of bicarbonate (pH kept between 6.7 and 8.1 mmol/L osmolality) as well as calcium (to protect endothelium transport pumps)
- BSS plus - as above but also contains glutathion (this is believed to improve endothelial cell adhesion complexes)
- The authors have had positive experience with a home-made preparation (immediately prepared before surgery) containing the following:
  - 1000 ml Hartmanns
  - 1 ml 1:1000 Adrenaline
  - 1 ml 1000 IU/ml Heparin

- Viscoelastics/Viscodispersives
  - As important for ocular microsurgery as microscope, instruments, phacoemulsification machine and suture materials
  - Multiple uses (only select few are named below):
    - Inflation and maintenance of anterior chamber and capsular bag
    - Coating and protection of surfaces (corneal endothelium, IOL)
    - Ocular surface protection
    - Iris manipulation: improvement of mydriasis, repositioning of iris prolapses, freeing of adhesions
    - Tamponade of intraocular haemorrhage
    - Tamponade of small posterior capsular tears
  - Various viscoelastics/viscodispersive substances are available, with hyaluronic acid (HA) as a viscoelastic and hydroxymethylpropylcellulose (HPMC) based preparations as viscodispersive substances being the most commonly used ones. These preparations are characterised by the following five key points:
    - Viscosity - the higher the viscosity, the better the anterior chamber is maintained and the less viscoelastic is lost through the incision wound
      - (HA >> HPMC)
    - Elasticity - functions as a ‘shock absorber’ for the endothelium, protecting it against the ultrasound waves during phaco
    - Pseudoplasticity - if placed under shearing powers, substances with high pseudoplasticity can be injected through a very small cannula
      - (HA >> HPMC)
    - Cohesiveness - measure of a substance to stick to itself. Substances with high cohesiveness tend to provide superior anterior chamber maintenance but can under pressure ‘exit’ the globe rapidly
      - (HA >> HPMC)
Coatability - ability of a substance to adhere to another surface. Required for protection of intraocular structures and the IOL during insertion. In general, coatability is high if cohesiveness is low - which in turn means that these substances may be difficult to remove entirely from the eye at the end of surgery - with a risk of post-operative IOP spikes.

- (HPMC >> HA)
  - Many surgeons will use HPMC for coating of cornea and anterior chamber during rhexis and phacoemulsification as well as during IOL implantation whilst choosing HA to inflate the capsular bag and to manage small posterior tears.

Anaesthetic requirements

Ideally, a veterinary anaesthetist would be available for all phacoemulsification procedures. However, this is not necessarily possible and a specifically trained nurse may have to fill this place. Consider enrolling your nurse on the Veterinary Technicians Specialisation - and to send him or her to visit other veterinary ophthalmologists to gain experience.

Pre-medication: A combination of opioid agonist and acepromazine is appropriate for most patients. The pre-medication is not only for pre-anaesthetic sedation but will hopefully influence the quality of recovery post-operatively. The routine use of systemic Atropine to prevent the rare complication of the oculocardiac reflex is not recommended.

Induction: Place the catheter in a hind leg for easy access. Avoid the use of Propofol if possible as this will lead to acute pre-operative hyperlipidaemia (undocumented personal experience) and may thus result in lipid aqueous and potential aggravation of post-operative uveitis. Alfaxan would be the alternative choice of induction agent. A guarded tube should be chosen to avoid occlusion during positioning (which usually involves bending of the neck).

Maintenance and Monitoring: The anaesthetist is positioned at the back end of the patient. Access to the patient’s body may be enhanced with a cage (Fig.2) that raises the drapes. Minimum requirements for monitoring include the following:

- Heart rate (pulse palpation)
- Temperature
- ECG
- Pulse oximetry
- End-tidal CO2
- Blood pressure
• Train-of-4 (TOF) - this must be placed and tested **BEFORE** muscle relaxation is induced

**Pre-operative preparation**

The ocular surface with its mucosal components is, according to WHO guidelines, considered a ‘clean contaminated’ space. Together with this fact and with the knowledge, that placement of an intraocular lens (implant) is usually intended (and that bacterial infection would be devastating in this situation), the use of prophylactic antibiosis is justified. However, this has changed significantly over the last decade. In veterinary medicine, it has been shown that bacterial contamination of the anterior chamber during phacoemulsification is common and that the source of this contamination is usually the resident flora on the ocular surface (Ledbetter et al., 2004). Options to minimise this are the use of topical broad spectrum antibiotic 12-24 hours pre-operatively or every 15 minutes for two hours pre-operatively (Ofloxacin) (Yu-Speight et al., 2005). On induction, a bolus of iv-antibiotic (potentiated amoxycillin) combined with a subcutaneous longer-acting form of the same drug (Ampoxycillin and Clavulanic acid) is given.

In 2007, the ESCRIS (European Society of Cataract and Refractive Surgeons) published the results of a ten-year, prospective study on endophthalmitis. The study included 16,000 patients undergoing cataract surgery in nine European countries across 23 medical centres. In 2013, a detailed booklet summarising the key information was published: “ESCRS Guideines for Prevention and Treatment of Endophthalmitis Following Cataract Surgery: Data, Dilemma and Conclusions“. Two key factors are a minimum contact time of three minutes between 5 to 10% of povidone-iodine solution and the ocular surface, and the use of intracameral cefuroxime at the end of surgery. Various studies detailed in the guidelines showed that the use of peri-operative topical antibiotic therapy provided no additional benefit.

**Preparation of the surgical field**

- No clipping
- Cut lashes only with scissors
  - Coat lashes with lubricant to minimise hair on ocular surface
- Sterile prep: 1:50 Povidone Iodine preparation (for example Betadine®) (Roberts et al., 1986)
  - USE SOLUTION, NOT SOAP
  - Clean depth of upper and lower conjunctival fornices and space behind the third eyelid with sterile cotton buds or cellulose sponges
• This is where the ultrasound gel hides!
  o Flush surface repeatedly with the povidone solution - using a syringe and a plastic nasolacrimal cannula or the plastic part of an iv-cannula
  o Minimum contact time 3 minutes
  o Prep lids and perioperative area by wiping with povidone-iodine solution-soaked lint-free swabs
  o Finally flush with sterile saline to prevent contamination of anterior chamber with povidone solution (toxic to intraocular structures)

**Organisation of the operating theatre**

How the patient is exactly positioned is entirely based on surgeon preference and two very different approaches will be shown (Fig. 2-4). In veterinary medicine, the patient should be positioned by the surgeon and not by someone else as this might lead to a suboptimal start of the procedure (this is very much appreciated by anyone who teaches phacoemulsification to a resident and might have to swap places mid-procedure). The following tips on the organisation of the theatre are however generally helpful:

Head end of the patient:
- Surgeon
- Microscope
- Phaco machine
- Instrument table

Foot end of the patient
- Anaesthetist
- Monitors
  - Ideally place pulsoximeter on toes, prepuce or vulva, avoid tongue
  - Blood pressure cuff on the hind leg that does not carry the iv-access
  - Infusion
- Patients are generally in dorsal recumbency with slight rotation of the body away from the operated eye
  - Use an angled connector for anaesthetic tubing
- Consider use of vacuum mattress unless this elevates the patient too high to allow an adequate working distance between eye and microscope
- The patient’s head should be on a level with the end of the table
- The eyelid opening should be horizontal to the microscope
  - If pupil horizontal improved fundic reflex, which is helpful for rhesis in immature cataracts
• A small chopping board can be placed under the head of the patient to protrude from the table to support the fluid-catch bag
  o This reduces pressure on the globe and minimises tendency for vitreal push
• A metal cage can be placed across the patient’s chest
  o This allows safe securing of the surgical drapes
  o Improves monitoring of chest movement/patient access for anaesthetist
• Duct tape can be used to secure the patient to the table or the head to the metal cage (CH)
• The head can also be placed in position with the use of a vacuum pillow (Buster® bag) (HF) - this allows excellent positioning but carries a small risk of deflation and loss of positioning during the procedure. This risk is minimised by the bag being deflated for at least an hour as a means of ‘testing’ i.e. when the theatre is first set-up.

**Surgeon’s position**

• The surgeon should be seated at the end of the table with the legs placed under the table
  o It is really important that the legs fit comfortably and securely underneath
  o The foot pedals for microscope and phaco machine must be in secure and easy reach
  o If this cannot be achieved, consider turning the table around as the ‘far end’ might be more suitable
  o With large dogs, it may be necessary to remove positioning devices that elevate the patient (such as the Buster bag) to allow increasing table height whilst keeping a suitable working distance between eye and microscope
  o The chair should have arm rests to allow fine hand manipulations
    ▪ These can be positioned at the front or the sides
• If a vacuum pillow is used for head positioning, this can provide additional hand support for the surgeon once draped

**Microscope set-up procedure**

1. Set the microscope to neutral position by pushing the centre/x-y axis button
2. Adjust personal dioptries and interpupillary distance
3. Centre microscope over eye
4. Focus in highest possible magnification
5. Then reduce to low magnification and ensure still in focus
6. Check assistants view and video images are in focus/adequately centred
Phacoemulsification - the actual procedure

Draping

- Watertight cover with approximately 2-5 cm opening for access to eye
- Secure to cage if used
- Apply sticky clear drape with reservoir for irrigation fluid collection (the authors like the ALCON visidrape (Alcon, Hemel Hempstead, UK)
  - Ensure lids are dry so sticky drape holds well
  - Open the palpebral fissure during application of the drape - this allows the creation of ’flaps‘ following an incision into the drape along the centre of the palpebral fissure which can be folded around the eyelid margins on insertion of the speculum
  - Take care the speculum is light and does not place pressure on the globe
    - Both the Barraquer sliding wire speculum and the Barraquer wire speculum are suitable
  - A canthotomy should be avoided if possible as these are irritating for the patient post-operatively and there is a high risk of wound breakdown with the use of frequent topical steroids post-operatively
- If required, place stay sutures to keep the third eyelid out of the operating field
  - Some surgeons also like to place a ’stay suture‘ at the conjunctiva in the six-o-clock position right behind the limbus as this might be helpful to improve visibility of the ventral lens periphery
- The fluid catch bag must not hang free but must be supported by the table or the Buster® bag as otherwise the increasing weight of the filling bag will produce pressure onto the ocular surface (increasing the risk of vitreal push). This can be avoided with the use of the ’chopping board‘ which is placed as described above and which is situated in the lap of the surgeon.

Setting of the operating table

In the absence of an assistant, it is important that the operating table is clearly organised and that instruments are laid out in the order, in which they are intended to be used (Fig. 5 and 6). Additional supplies of viscoelastic materials, sutures, intraocular irrigating solution and vitrectomy equipment should always be at hand. Intraocular lens implants are often not opened until phacoemulsification is completed and until the surgeon can decide whether an implant can be placed and which the most appropriate size and type of implant will be. As most surgeons will carry out intraocular surgery in a darkened room it might be advisable to place an operating spot light, which however is directed away from the
surgeon, above the instrument table. Finally, traffic in and out of the operating theatre should be kept to a minimum (Fig.6).

Entry into the anterior chamber

- Usually between 11 and 1 o’clock (more temporal in the right eye and more nasal in the left eye).
- Scleral tunnels have proven difficult in canine phacoemulsification:
  - Excessive bleeding
  - Restriction of reach with phaco needle
- One author mostly uses a single step, clear corneal 45 degree stab incision with a single use 2.8 mm phaco lance
  - the incision is started immediately adjacent to the limbus
- A two step clear corneal incision (to improve wound sealing and decrease fluid loss from the anterior chamber) with an initial perpendicular bevelling incision followed by an angled stab incision is used by one of the authors
- Longer corneal ‘tunnels’ carry a high risk of excessive stromal oedema and may be associated with poor wound healing
- If the incision inadvertently crosses the limbus and ‘cuts’ the conjunctiva, fluid leaking from the corneal wound may be directed under the conjunctiva and result in ‘conjunctival ballooning’. In mild cases, this is a minor nuisance but in severe cases, it may significantly impair visibility of the anterior chamber and also might make suturing of the corneal closure difficult. Some surgeons suggest ‘relieving’ such trapped fluid by multiple conjunctival incisions - however, neither author has had any luck with this!
  - If a conjunctival incision has occurred and this is noticed, it is preferable to immediately close the corneal wound one with a suture and to start surgery with a new incision just to the side of the first one
- For a two-handed technique, a second incision for the side port is created approximately 70-90 degrees away using a 15 degree knife with a limbal stab incision (one author routinely creates this incision before the larger 2.8 mm incision)

Injection of Viscoelastic

- Immediately following the entry into the anterior chamber, viscoelastic is injected to maintain the anterior chamber and to maintain mydriasis. It is a surgeon preference whether and HA or an HPMC based viscoelastic is used here; however, for less experienced surgeons HA is recommended, as this will provide improved anterior chamber stability for the rhexis. When injecting the Viscoelastic, ensure that the syringe is ‘primed’ to avoid introducing annoying air bubbles and inject the Viscoelastic
from the distal aspect of the anterior chamber slowly towards the wound, expelling and replacing the aqueous humour.

Wetting of the corneal surface

- In veterinary ophthalmic referral practice, it is not usual to have an assistant handing instruments and wetting the corneal surface. The latter can usually be accomplished with the application of HPMC onto the corneal surface 2-3x during the procedure. Care should be taken not to touch the corneal surface with the tip of the cannula to avoid contamination from the corneal surface.

Capsulorrhexis

Continuous circular capsulorrhexis (CCC) is the gold-standard for human cataract surgery and describes the removal of an approximately 4-6 mm diameter round central aspect of the lens capsule by a combination of shearing and tearing. The integrity of the CCC is essential for the result of the phacoemulsification as it is the key-stone for maintaining stability of the remaining capsular bag and for preventing radial tears with subsequent loss of cortical material during phacoemulsification. In human medicine, the CCC is usually performed with specific toothed forceps (Utrata) or simply with a needle. This is also possible in young canine patients without capsular plaques or areas of capsular thickening. In older dogs however, the anterior lens capsule is often thickened and fibrosed and it is difficult to carry out a rhexis purely by tearing with a needle or forceps. In such patients, it may thus be preferable to cut hardened or fibrosed parts of the rhexis (especially in fibrosed areas) with Vannas scissors after the initial small ‘hole’ into the capsule has been made with the tip of an insulin syringe. Care must be taken not to create small tears or irregularities in the edge of the rhexis as these will be predisposed to tear out radially when strain is placed onto the rhexis during phacoemulsification or IOL implantation. One such weakness can easily be created if the rhexis is performed by not only cutting into one but both directions (both medially and nasally) with Vannas scissors. In a fibrosed and dense canine lens capsule, it may be preferable to have a ‘safe’ start to the rhexis by making incisions in both directions and the small risk of a peripheral tear may be acceptable. To achieve a good rhexis, it is of importance to maintain a deep anterior chamber and to flatten the anterior lens capsule with the injection of viscoelastic as much as possible. A shallow anterior chamber will allow the anterior lens capsule to become more convex - which in turn will encourage a rhexis to ‘go’ more peripherally and predispose to capsular tears. If the capsule starts to go radially, it must be retrieved by changing the direction of tearing and if necessary, scissors should be employed to cut any flaps and retrieve the situation.
Visualisation of the lens capsule for the rhexis is improved if the fundic reflex can be utilised. As many of our patients have advanced (‘white’) cataracts, visualisation of the capsule may be poor and the use of capsular stains such as 0.06% trypan blue (Vision blue®) can be very helpful. The following steps should be followed when using the stain:

- A large air bubble is introduced into the anterior chamber first
- 0.5 ml of trypan blue stain for intraocular use is introduced underneath the air bubble, just above the central anterior lens capsule
- The dye is then flushed out with irrigation/aspiration
- Even if the lens capsule does only appear lightly stained, it will now be very clearly distinguishable from the bulk of the ‘white’ cataract material once the rhexis is started
- The stained rhexis margin will have improved visibility throughout the procedure

A further complicating factor when performing the capsulorrhexis in very ‘ripe’ cataracts is the egress of ‘cortical milk’ upon the first incision into the capsule. To improve visibility here it is advisable to aspirate this liquefied lens cortex and then to re-fill the anterior chamber with viscoelastic.

**Hydro-dissection**

Hydro-dissection is carried out to mobilise the lens nucleus and cortex from the lens capsule. This ‘freeing’ of the bulk of the cataract material is essential if ‘splitting’ of the hard part of the cataract with several ‘rotating’ movements is to be attempted in bi-manual methods (see below). To perform hydro-dissection, the following steps are followed:

- The anterior chamber is well maintained with a viscoelastic
- A 2 ml syringe with a 27 gauge blunt cannula (you can use spare viscoelastic cannulas) is filled with the phacoemulsification irrigating solution.
- The cannula is then inserted underneath and immediately against the anterior lens capsule via the rhexis opening and the cannula is gently pushed onto the cataract
- Fluid is flushed through the cannula against the capsule and is visualised as a fluid wave around the nucleus
- This is repeated multiple times in various quadrants around the lens until the entire nucleus and hard cortex are mobilised

Hydrodissection is not suitable for any cataract that might be associated with capsular instability, potential capsular ruptures or for cataracts that are firmly attached to the posterior lens capsule and namely the following have to be considered with care with regards to hydrodissection:
• Subluxated lenses (mobilisation of the cataract material increases the risk that lose cortical material inadvertently is lost into the vitreous via the unstable zonular ligaments)
• Intumescent cataracts
• Cataracts with posterior lenticonus/PHA or PHPV
• Posterior polar subcapsular cataracts

Ideally, ocular ultrasonography should be carried out prior to surgery to ensure that pre-existing posterior capsular tears/ruptures are not present.

**Phacoemulsification**

Endless methods, all of which aim to speed up the safe removal of cataract material are reported in human ophthalmic surgery - and most have been given snazzy abbreviations such as TDC (trench, divide and conquer), CDC (crater, divide and conquer), phaco flip and chop, chop and stop.... and so on. However, when applying the described human approaches to canine patients regardless of taking the different aetiologies of their cataracts, the different stages of maturity and the differences in the anatomy of the canine eye and lens into consideration, one will quickly run into difficulties during surgery and experience potentially serious complications. Firstly, most cataracts that are being operated on in humans would not even be classified as a cataract in our patients - but rather as ‘nuclear sclerosis’. Even with continued further education of our referring veterinary surgeons, most of our patients have rather advanced cataracts, which are often associated with capsular instabilities. To rigidly adhere to a set routine including hydrodissection can quickly result in serious capsular tears and loss of the entire cataract into the vitreous in such patients. The canine lens also has a much larger volume, which makes it difficult to manoeuvre the mobilised cataract about and care must be taken not to exert excessive strain onto the capsular bag or zonules during mobilisation procedures. Finally, whilst common sense suggests that short phacoemulsification times and low ultrasonic power used should be significant factors involved in improving the outcome of canine cataract surgery, peer-reviewed studies to show that this is indeed the case are currently lacking. It might therefore be preferable to take a little longer using overall lower settings both for phaco power and AFR to avoid complications caused by damage to the posterior capsule with the phacoemulsification needle caused by surge or phaco-power.

To date, both single and two handed approaches are used by experienced veterinary ophthalmologists (Wilkie and Colitz, 2013).
In cataracts, where capsular stability is good and where hydrodissection is appropriate and can be successfully carried out, many variations of the below described two handed approach can be attempted:

- A trench, at least twice as wide as the phaco needle is created in long strokes from 12 to 6 o’clock to a depth of 75-90% of cataract thickness
  - At this point, relatively low vacuum but high phaco power settings are applied - the high ultrasound power is ‘buffered’ from the posterior lens capsule by the remaining cortical material
- Sudden dispersion of cataract material resulting in acute ‘clouding’ around the tip of the phaco needle or larger areas of the anterior chamber indicate that the phaco tip is too deeply embedded into the cataract and that the tip and possibly also irrigation ports are occluded - which is not desirable as it is not efficient, disperses cataract material within the eye and also presents a risk for corneal burn as the phaco needle may not be adequately cooled whilst the irrigation sleeve is blocked
- Once the trench has been completed to the desired depth, phacoemulsification handpiece and side instrument are inserted deep into the centre of the trench (the instruments can be crossed over or used on the side of the trench, on which they are inserted) and the lens is ‘split’ into two halves
- The lens is then rotated 90degree clockwise (if the surgeon is right handed) and a second trench is created (ideally, at 180 degree from the first one)
  - Again, low vacuum and high ultrasound power are used
- Similar to the first trench, the new trench is used to split the two distal lens quarters from each other
- The lens is rotated clockwise again and the last remaining half is split into two quarters
- One by one, each segment is engaged into the phacoemulsification tip, gently lifted towards the opening of the anterior rhexis and emulsified
  - Here, higher vacuum levels assist in engaging and lifting each segments whilst lower ultrasound power settings are applied

In practice, it is often not possible to achieve a break-up in exactly four segments and smaller ‘wedges’ of cataract can be created and emulsified. Spontaneous hydrodissection along the suture lines commonly occurs in canine diabetic and other canine intumescent cataracts and here it may be possible to split the lens into fragments even with one-handed phacoemulsification techniques.

Methods including the use of a sharp instrument (the phaco ‘chopper’) to break the nucleus manually have been described but are not favoured by the authors (Warren, 2004).

Alternatively, a large central bowl can be sculpted with one-handed techniques and then slowly ‘cracked’ by engaging the edge of the thin remaining posterior ‘shell’ of cataract
and lifting it towards the rhexis, where higher bursts of phaco power are utilised to emulsify it. This approach is risky for beginners as the shell provides very little lens material between the phaco tip and the posterior lens capsule - it is easy to create a posterior capsular tear and miss the mistake until it is too late. Another option is to divide nucleus into pie-shaped sections - this can be achieved by a central groove followed by two oblique grooves making a Y-pattern. The nucleus can be rotated 180 degrees to allow a second Y-pattern to be created. The result is six sections, albeit slightly different sizes. The authors would not recommend ‘nucleus-flipping’ methods for the nuclear shells as the risk of sudden capsular tears is significant with the large canine cataracts, which can also have very sharp edges that could cut the capsule during the flipping manoeuvre. Finally, in puppies, it may be possible to remove the often soft cataract by aspiration only.

Irrigation/aspiration

Soft cortical material is removed by careful irrigation and aspiration. The lens equator is usually not visible as it is obscured by the iris even in maximal mydriasis and most of the aspiration is carried out ‘blind’ in the periphery. Irrigation handpieces should have both straight and angled tips and an almost 90 degree angle tip is helpful to remove cortex underneath the area of the corneal incision. Ideally, aspiration tips should have an opening of 0.5-0.7 mm - however, many of the angled tips only have openings of 0.2-0.3 mm diameter - through which it may be very difficult to aspirate the often thick canine cortex. Some of the hereditary cataracts such as the posterior polar cataract may have focal adhesions to the posterior lens capsule. In some cases, these can be loosened with aspiration and it may be necessary to gently ‘suck the lens capsule’ in the affected area into the port to tease the cataract plaque loose. This is of course fraught with the risk of a posterior capsular tear - and it will take years of experience for a surgeon to learn how much suction can be applied to an individual lens capsule.

Posterior capsular opacities

If it is not possible to aspirate posterior capsular opacities and if these are too dense or numerous and are affecting the visual axis, removal of the affected area of posterior central capsule (posterior capsulorhexis) is required. Although a direct connection between planned posterior rhexis and the development of complications such as a retinal detachment has not been shown in canine cataract surgery (Johnstone, 2005), the authors remain highly suspicious that breaching the posterior capsule predisposes to the development of complications such as retinal detachment. For this reason, one should
always ask oneself whether a planned posterior rhexis is truly required to restore useful sight before proceeding.

The posterior rhexis is ideally carried out in a controlled manner after the capsular bag has been inflated with a high viscosity viscoelastic (HA). As the posterior capsule is much thinner, it is often possible to carry out a CCC with a fine needle only. However, in case of solid plaques or folds in the capsule, cutting of the posterior capsule with long Vannas scissors or specific vitreo-retinal scissors may be required. If the posterior lens capsule is difficult to reach with scissors or if it has torn radially and retrieval with forceps proves very challenging, it can be considered to ‘nibble’ the capsule with the vitrectomy handpiece. However, the rhexis being created in this manner is not smooth and more prone to radial tearing during IOL implantation. Also, the use of automated vitrectomy (especially a one-handed approach) increases the risk of inadvertently increasing the size of the capsular tear. A small amount of HA can be injected underneath the lens capsule to separate it from the vitreous and keep the vitreous back during extraction of the piece of capsule. Where dense adhesions between capsule and vitreous exist, it may be necessary to cut the vitreous ‘off’ the posterior lens capsule with scissors. In cases, where vitreal degeneration is pre-existing, automated subtotal vitrectomy must be considered to prevent vitreal herniation. Ideally, the posterior rhexis should be central and approximate the size of the optic of the intended lens implant. Some surgeons may prefer placing the lens implant prior to performing a posterior rhexis.

**Intraocular lens (IOL) placement**

Both authors routinely use hydrophilic foldable acrylic lens implants. The decision, which exact type of lens implant to choose is individual preference and whilst studies have suggested hydrophilic acrylic implant to be potentially superior, this actually appears to be of very little clinical significance. For lens implantation, the anterior chamber and capsular bag must be inflated with HPMC. One author (CH) would recommend the use of HA to inflate the capsular bag as stably as possible if a posterior rhexis or tear is present. It may be necessary to increase the corneal incision by 1-3 mm for most foldable acrylic implants if a 2.8 mm corneal incision has been created. If the corneal incision is not enlarged, then the lens can usually not be introduced deep enough to allow placement of both haptics under the anterior lens capsule. Instead, the leading haptic can be introduced into the bag and the trailing haptic initially emerges into the anterior chamber on top of the capsular bag. A lens manipulator is then used to gently push the leading haptic further in with a rotating motion until the trailing haptic has also been placed into the capsular bag. Prior to injection of the lens implant into the anterior chamber, it is important to ‘prime’ the lens injector by starting to inject prior to introduction of the injector into the anterior
chamber to ensure a) that the lens implant glides smoothly through the injector and that b) the anterior chamber is not over-inflated with excess viscoelastic from the injector.

Removal of viscoelastic by irrigation/aspiration/Wound closure

The above two steps are in our hands carried out combined as it is important that wound stability has been secured prior to the removal of the viscoelastic from the anterior chamber.

The authors both use 9/0 Vicryl® in a simple continuous pattern for corneal closure. For a right-handed surgeon, wound closure starts from left to right in a classic or symmetrical saw-tooth pattern. The distal side of the suture is placed into the clear cornea whilst the proximal suture emerges on the scleral side of the limbus. Knots are created using a 2 or 3/1/1/1/1 pattern as the fine monofilament suture has memory similar to a nylon thread. All knots are left on the corneal surface as knots made by 9/0 vicryl are too bulky to be buried. Unlike recommended in most textbooks, both authors recommend that suture ends are left long (3-4 mm) as these will become soft and pliable once soaked in tears - whilst short suture ends as usually recommended will ‘stick up’ and result in adnexal irritation (including conjunctival ulceration). Prior to tightening and knotting the suture, the I/A probe is inserted between two sutures and the viscoelastic is aspirated. Appropriate aspiration over a period of 60 seconds has been associated with a reduced incidence of post-operative hypertension (Klein et al.) . Carbachol (0.3-0.5 ml) can be instilled via the side-port or main incision to aid preventing post-operative hypertension (POH) and to check for dyscoria - one of the authors uses this routinely whilst the other only uses it for dyscoria; both being aware that evidence for the efficacy of this treatment for POH is debated (Crasta et al., 2010, Stuhr et al., 1998).

The side-port is closed with a single simple interrupted suture at the very end of the procedure.

Post-operative IOP monitoring and management

Post-operative ocular hypertension is common in the immediate post-operative phase of canine cataract surgery (Azoulay et al., 2013, Biros et al., 2000, Chahory et al., 2003, Crasta et al., 2010, Johnstone, 2005, Klein et al., Moeller et al., 2011, Smith et al., 1996, Stuhr et al., 1998). The authors agree with this finding and have experienced some severe and blinding cases of POH. For this reason, patients are hospitalised for approximately 24 hours post-operatively and undergo regular IOP measurements. For the first 6 hours, these are carried out hourly to establish a trend. Further readings will be obtained throughout
the night as required. A cut-off for instigation of IOP lowering treatment is usually around 25-30 mmHg. Medical treatment comprise the use of Prostaglandin analogues, Carbonic-anhydrase inhibitor/timolol combinations or alpha2 agonists. Occasionally, aqueous paracentesis with a blunt cannula through the wound is required and Mannitol infusions are also used. The treatment is tailored to every patient and specifically the extent of POH, health status and temperament of the patient are significant factors.

Post-operative medication

Aims:

• Prevent post-operative infection
  o Topical antibiosis for approximately 7-10 days (until wound vascularised)
    ▪ Ofloxacin qid
    ▪ Chloramphenicol qid
  o Systemic antibiosis
    ▪ Potentiated Amoxycillin bid for 5-7 days (potentially 14 days in high risk patients with Diabetes, Cushing’s syndrome etc

• Minimise uveitis
  o Topical steroid
    ▪ Prednisolone acetate 1% 4-6x daily 10 days, then gradually reducing - for example 4x daily 2 weeks, then 3x daily 2 weeks, then 2x daily 6 weeks, then 1x daily 6 weeks
    ▪ When topical steroids withdrawn, change to long term use of topical NSAIDs (with the aim to suppress subclinical PCO uveitis and PCO formation - although again this is debateable (Bras et al., 2006, Brookshire et al., 2014))
  o NSAID’s in case of corneal disease
    ▪ Ketorolac trometamol 0.5% 4x daily - gradually reducing

• Avoid adhesions
  o Tropicamide 2x daily 2 weeks, 1x daily 2 weeks, then discontinued

• Use of IOP lowering drugs as required

Trouble shooting for intra-operative complications

Intraocular haemorrhage

• Haemorrhage from ‘clear corneal incisions’ into AC less likely than from limbal based or scleral incisions
• Loss of IOP on corneal entry can result in spontaneous iris haemorrhage
  - Attempt self-sealing incision as much as possible without compromising reach of phaco needle
  - Use viscoelastics copiously
• Add Adrenaline 1:1000 1 ml to 1000 ml iv fluid
• Possibly most important - patient selection: high risk patients include patients with lens induced uveitis or post-traumatic cataract patients; here careful pre-operative uveitis management may be indicated

**Miosis**

• Pre-operative induction of mydriasis with tropicamide (2x q 30 mins pre-operatively)
• If required (in case of post synechiae) Atropine use several days pre-operatively
• Adrenalin in irrigating fluid as described above
• Topical NSAID’s (ketorolac trometamol) given q 15 minutes over 1 hour pre-operatively help to prevent miosis associated with the use of prostaglandin release
• Use of HA based viscoelastics to mechanically aid in pupillary dilation
• Potentially intracameral adrenaline (0.1-0.5 ml of 1:1000 Adrenaline dilution)

**‘Vitreal push’**

• Common in brachycephalic breeds
• Check simple things first e.g. speculum, unsupported pouch of adhesive drape heavy with fluid and causing marked ‘drag’ effect
• Created when vitreal hydration occurs during surgery - caused by irrigating fluid which is ‘pushed’ into the vitreous either via capsular tears or zonular instabilities
  - Bottle height is critical to vitreal hydration (Kang et al., 2014) higher positions provide higher anterior chamber stability but will result in increased vitreal hydration (see table)
• Manifested by bowing of posterior lens capsule towards the anterior rhesis - in severe cases the posterior capsule can bulge over the rhesis
  - Specifically problematic if IOL implant is being dislodged
• Once noted, fill capsular bag with HA, gently pushing the capsule back and carefully check for any capsular tears - these should be tamponaded with HA
• Raising the bottle height might be helpful in the short term in pushing the posterior capsule back - however, with time this might worsen vitreal hydration and is thus not recommended. Instead, it might be preferable to reduce bottle height and AFR to reduce further vitreal hydration
• Attempt to complete the procedure as rapidly as possible and achieve secure closure of the corneal incision
• Some textbooks suggest a Mannitol infusion – however, this is in the author’s experience impractical given the time implications
• Instead, in severe cases, where the procedure can otherwise not be completed or where IOL placement is not possible, posterior rhesis and vitrectomy might be required

Vitreal herniation

Vitreal herniation is usually associated with

• Posterior capsular tears
  o Iatrogenic
    ▪ Ideally avoid by
      • Improved CCC technique
      • More careful sculpting
      • Low phaco energy in area of posterior lens capsule (ideally phaco in the pupillary zone)
      • Control small lens segments with the side instrument - these can be ‘propelled’ against the posterior lens capsule by ultrasonic energy and cause tears if they are sharp
      • Consider using lower aspiration flow rates - reduced risk of surge
      • Careful hydrodissection - avoid in rapidly developing/intumescent cataracts, cataracts in young patients and diabetics
      • Careful use of the side instrument or phaco chopper

• Zonular instabilities
  o Herniation of degenerate vitreous around lens equator
  o Tendency to following fluid escaping through wound - becomes trapped in corneal incision

Herniated vitreous has a tendency to be aspirated by the phaco-needle and will block it. It may be invisible to the surgeon and is often only noted by the lack of ultrasonic effect on lens fragments when the foot pedal is in position 3 and the noise emitted during phacoemulsification can be heard. It can be made ‘visible’ with the use of intracameral triamcinolone (see afternoon lectures on vitreal herniation). Herniated vitreous is generally removed by vitrectomy although small strands can be cut and removed with intraocular scissors. Avoid pulling on strands of vitreous as this may predispose to retinal detachment.
Loss of cortical material into the vitreous

- Usually caused by equatorial or posterior capsular tears
- Serious complication as retrieval of lens material from the posterior segment can be extremely difficult
- Extensive vitrectomy and the use of high viscosity viscoelastics will be required to attempt to ‘float’ pieces of cortical cataract back into the pupillary zone, where they are embedded onto the phacoemulsification needle by high vacuum and emulsified
- If a large tear is detected early (i.e. before the loss of cortical material) it must be considered to abandon phacoemulsification and to convert to manual cataract removal via a large corneal incision (170degree) after filling the anterior chamber with viscoelastic. Once the ‘bulk’ of the cataract material has been removed with a vectis, partial wound closure is carried out and the operation is completed using irrigation/aspiration and if required vitrectomy. A large corneal wound is preferable over a dropped nucleus - during whose retrieval a retinal detachment or haemorrhage could easily be induced

Unstable capsular bag

- Causes:
  - Primary zonular defects
  - Age-related
  - Associated with chronic lens induced uveitis
- Ideally diagnosed prior to surgery to allow planning
  - Always ensure cataract patients are examined in maximal mydriasis (>30 minutes after application of tropicamide) pre-operatively as mild zonular defects will be missed otherwise
- Consider use of a capsular tension ring
- Pre-groove for long incision but make only focal full thickness stab incision
- Two handed technique with side-instrument stabilising capsular bag
- Keep the rhexis small (3 mm approx)
  - To avoid loss of cortical material into vitreous during phacoemulsification
  - To provide appropriate remaining capsular integrity if it becomes apparent that the lens is too unstable for phacoemulsification and if a switch to an intracapsular technique is required
  - Use scissors for majority of rhexis
  - Perform shearing/tearing action towards rather than away from area of zonular weakness if possible
Difficulties with IOL placement

- If anterior rhexis too large (easily happens in young patients!)
  - Choose a lens implant with large and stable haptics
  - Consider suture lens (PMMA?)
- If defect in posterior lens capsule
  - Lens placement is still possible if defect smaller than haptics (defect can be size of optic and optic can reach into anterior vitreous ‘optic capture’)
  - Inject lens through smallest possible corneal incision (provides better stability of AC and lens bag)
  - Use a lens that is soft, pliable and unfolds very gently

References and further reading


Fig. 1 Laminated cards showing the instruments belonging into the microsurgical kit used for phacoemulsification. These cards help the nursing team to recognise each instrument and to ensure that the kit is kept complete.

Fig. 2 Method used to position the patient by one of the authors. Note the metal cage which is placed across the patient’s chest and which is used to secure the patient to the table and to elevate the drapes. In addition, the head is positioned by being duct-taped to the cage.
Fig. 3  Positioning used by the other author. Note use of the vacuum pillow to aid positioning of the head. To keep the surgical field as clean as possible, the mouth has been bound with elastic self-adhesive bandage.

Fig. 4  Same patient as Fig. 3 - close up view from surgeon’s position. Note the horizontal positioning of the palpebral fissure and the fact that the periorcular hair is not clipped. The patient is wearing a yellow collar highlighting to every member of the team that we are dealing with a diabetic patient.
Fig. 5 The surgical instruments are being laid out in order of use in the surgical tray for easy access

Fig. 6 The operating field viewed from the surgeon’s position.
Fig. 7 Traffic through the operating theatre should be kept minimal to maintain maximal sterility and also to avoid disturbing the surgeon during microsurgery.
Most trainees have never really been taught how to properly perform an anterior vitrectomy. We all need to understand the instruments, to know the appropriate machine settings, how to use the instruments and the details of how to perform anterior vitrectomy. These are critically important in order to obtain the best possible outcome so that the final result following anterior vitrectomy is as good as if it had never happened. There is a clear strategy for dealing with vitreous loss that can be summarised as follows:

- Don’t panic
- Don’t deny it
- Visualise it
- Don’t pull it
- Remove it
- Follow it up

Don’t Panic
You should stay calm, which can be difficult, but you should learn to override the immediate brainstem reflex, which is to withdraw the instruments from the eye. Leave the irrigating instrument in the eye (whether phaco or I/A) with the irrigation still running in order to keep the vitreous tamponaded whilst you perform a BSS/OVD exchange that will fill the chamber with viscoelastic. Do this by inserting the OVD cannula through the sideport and start to inject the viscoelastic while turning off the irrigation. Leave the irrigating instrument in the eye in order to occlude the wound whilst the chamber fills. As it fills you can safely remove the irrigating instrument without the risk of chamber collapse and vitreous prolapse.

The first thing you can then assess is whether or not the vitreous face has in fact been ruptured or whether all you have is a PC tear with an intact anterior hyaloid face. PC tears usually occur at the end of phaco with removal of the final fragment or, more commonly, during I/A. In either case, fortunately, there are no longer any nuclear fragments around. If this is the case then the PC tear can be circularised, using rhexis forceps, into a primary posterior capsulorhexis and, using plenty of OVD to keep back the anterior hyaloid face, a lens can be safely inserted into the bag as planned.

Don’t Deny It
If there is obvious vitreous loss then you must strongly resist the temptation to deny that it has happened. It can be difficult to resist the temptation to continue as if everything was still proceeding as normal. However this is simply dangerous and will work against a good outcome. If there is vitreous around in the anterior chamber then you should not be using a non-cutting instrument in the eye, which very much includes the phaco probe. Ultrasound does not cut vitreous. If you continue to phaco then vitreous will inevitably be aspirated into the tip and traction will thereby be transmitted to the vitreous base (or any
other points of vitreoretinal adhesions) where it is highly likely to pull a retinal tear, leading to retinal detachment. Bear in mind that the RPE pump, holding the sensory retina to the underlying RPE, exerts a pressure of only 0.27mmHg!! The exact same principles apply to using I/A in the eye when there is vitreous around. So you should simply refuse to give in to the temptation to pretend that nothing has happened; have the honesty to admit that there is a problem and then sort it out. Pretending that things are otherwise will cause more problems and will result in a worse outcome.

Visualise It
One of the most significant innovations in the safe surgical management of vitreous gel has without doubt been the intraoperative use of triamcinolone acetonide to visualise invisible vitreous, pioneered by Scott Burk et al in 2003. Adoption of this technique has been slow but steady and has increased more recently since licensed preservative-free preparations have become commercially available. Alcon produces Triesence and Allergan produces Trivaris. There are a number of other preparations available from different manufacturers depending in which country you practice.

In principle a suspension of 40mg/ml (Trivaris is 80mg/ml) is diluted between two and ten times with BSS and injected directly into the anterior chamber. It adheres to vitreous and visualises otherwise invisible gel. A process accurately likened to “Cloaking the Ghost”. The excess suspension is washed out of the chamber and then the “snowsprinkled” gel can be vitrectomised. There is absolutely no other way of ensuring a complete and meticulous removal of all gel with total confidence. It is this complete removal which is so critical to preventing most of the complications associated with vitreous loss which nearly all relate to the persistence of residual vitreous gel in the anterior segment and incarcerated in the wounds (e.g. vitreous wick, endophthalmitis, VR traction, CMO, glaucoma, peaked pupil).

Don’t Pull It
The details of the technique and instrumentation that enables high quality anterior vitrectomy are simple but important to clearly understand. The key principles are to use separate disposable infusion and cutter (avoiding the older coaxial instruments) via an anterior approach (use corneal sideports; a pars plana approach has greater risks without demonstrable benefit) and to minimise pulling on the gel (high cut rate (as high as your machine will allow) with low vacuum (100-150mmHg) minimises vitreous traction). A low bottle height discourages turbulence and a tendency to additionally hydrate the gel and promote further anterior prolapse, but this has to be balanced against preventing collapse of the eye. In practice a bottle height of around 30cm usually works fine. You can use an AC maintainer instead of a separate infusion cannula although beware that you tend to get higher flow rates for a given bottle height through this short, open-ended & relatively larger bored alternative.
Remove It
The term “core vitrectomy” is the desired end-point and the generally referenced gold standard that we are all encouraged to aspire to. It sounds very precise and quite compelling. However, in practice it is a fairly soft-edged concept that is almost impossible to define specifically. In general we are referring to the “central” gel, which is around one third of the volume, whilst leaving the vitreous base and posterior gel alone, as this is not safely accessible using these instruments and set-up. In practice a core vitrectomy is whatever it takes to remove all residual gel from the anterior chamber. During vitrectomy the cutter tip and aspiration port should always be visible to the surgeon and the temptation to pass it peripherally under the pupil should be resisted. This is unnecessary and potentially dangerous. Keep the infusion cannula anterior to the iris pointing it across the chamber and preferably not posteriorly as this will result in additional hydration and further anterior prolapse of gel. Move the cutter around only small amounts within the pupil aperture using a gentle and smooth motion to avoid traction (recall the RPE pump pressure of 0.27mmHg?). You may want to turn up the vacuum to around 200mmHg as you make progress but any higher is usually unnecessary and causes greater traction in-between cuts.

If there is vitreous incarcerated in the main incision or sideport then remove it from within, using the cutter via the other sideport. Attempting to remove it through the main incision itself is impossible and will only encourage additional outflow and gel prolapse. If there are still lens fragments present when the vitreous prolapses then, after using triamcinolone, the safest way of removing them is to perform a “dry” vitrectomy without any infusion. This removes any entangled gel so that the fragments can be floated out, enlarging the incision as needed. Performing phaco on these fragments is a high-risk manoeuvre as gel traction is almost unavoidable. Any volume removed by the cutter is replaced using viscoelastic delivered simultaneously through a second sideport. This supports the fragments and prevents scleral collapse. Once the fragments are out then irrigation can be used to complete the vitrectomy.

At whatever stage the anterior vitrectomy is performed it is important to be careful not to damage the capsulorhexis, which in most cases will still be intact. You will be able to use the continuous rhexis to optic-capture the implant and secure it centrally in the correct anatomical plane. This only works with suitable 3-piece IOLs, not single-piece acrylics whose haptics are too bulky. These thick haptics angulate forwards (or backwards) if the IOL is in front of (or behind) the anterior capsule when the optic is captured, and cause iris chaffing etc.
Follow-up
Finally, these patients need an early post-op peripheral retinal examination preferably with scleral indentation in order to exclude any anterior breaks.

Vitreous loss is serious. Accept that it has happened, stay calm and decide on a surgical strategy. Respect the Vitreous Base by using high cut-rate and low vacuum with gentle movement of the instruments. Cut gel, don’t pull it. Visualise the vitreous with triamcinolone to ensure meticulous and complete removal of all gel from the anterior chamber. Avoid collapsing the eye.

By adhering to these clear and simple principles for managing vitreous loss you will be able to achieve a final result that is as good as if it had never happened. That is what everyone wants.
Vitreous Loss: Prevention

Brian Little, Moorfields Eye Hospital

Monday, 28 April 14

Why does it happen?

Pre-op risk factors
Accessible
Mobility
Poor view
Axial length
Small pupil
Advanced cataract
Zonular weakness

Managing Vitreous Loss: 8-point Plan

- Prevent it
- Don't deny it
- Don't panic
- Do Nothing?
- Don't pull it
- Visualise it
- Remove it
- Follow it up

Prevent it
Don't deny it
Don't panic
Do Nothing?
Don't pull it
Visualise it
Remove it
Follow it up

Vitreous Loss Prevention, Brian Little
Why does it happen?

- Operative risk factors; any stage
- Capsulorhexis
- Hydrodissection
- Phaco
- I&A
- Viscoelastic fill
- IOL implantation
- Miochol injection

How to perform the perfect tear-out

Capsular block: PC "pop"

If in doubt, sort it out

Operative risk factors

- Capsulorhexis
- Hydrodissection
- Phaco
- I&A
- Viscoelastic fill
- IOL implantation
- Miochol injection
Why does it happen?
- Operative risk factors
- Capsulorhexis
- Hydrodissection
- Phaco
- I&A
- Viscoelastic fill
- IOL implantation
- Miochol injection
Why does it happen?

Operative risk factors
Capsulorhexis
Hydrodissection
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Managing Vitreous Loss: 8-point Plan

- Prevent it
- Don't deny it
- Don't panic
- Do Nothing?
- Don't pull it
- Visualise it
- Remove it
- Follow it up

Causes of Complications

1. Act of God: unavoidable
2. Act of Surgeon: avoidable

Practical Approach

- RECOGNISE early warning signs of impending problems
- REACT to them before you're IN trouble

The answer to preventing all complications is....

Cognitive Skills*

- Information gathering
- Situation assessment
- Decision making

* Non Technical Skills for Surgeons (NOTSS)
Cognitive Skills

- Practical application in surgery
- Laparoscopic surgery
- Resident training, Baylor, Houston

Thank You
Managing Complications

........dealing with the unexpected

The answer to preventing all complications....

Cognitive Skills

• Components
  • Information gathering
  • Situation assessment
  • Decision making

Avoiding Vitreous Loss, Cognitive Skills, Brian Little
Cognitive Skills

- Practical application in surgery
- Laparoscopic surgery
- Resident ophthalmologist training, Baylor, Houston

Suprachoroidal Haemorrhage

- Rare but potentially devastating
- Incidence 0.04 - 0.15%
- 40% < 20/200

Pathogenesis

Information gathering
Situation assessment
Decision making

The answer to further reducing complications & minimising their impact?
Dear Colleagues

At the Animal Health Trust, we are investigating the genetics of goniodysgenesis-related glaucoma in the dog (multiple breeds) in conjunction with the Institute of Ophthalmology, University College of London.

We have been awarded funding from Dogs Trust to conduct this study over the next 6 years and I will be dedicating 100% of my off-clinics time to this study which will form the basis of my PhD.

We have already discovered one gene highly associated with goniodysgenesis and glaucoma but we need more samples to take this project further.

We require DNA (in the form of cheek swab or blood samples) from the following categories of dogs:

1. Dogs affected with goniodysgenesis and primary glaucoma
2. Dogs affected with goniodysgenesis (but not glaucoma)
3. Dogs unaffected with goniodysgenesis aged 5 or above

We also require ocular tissue samples (in RNAlater) of eyes affected by glaucoma.

If you would be willing to help with this research (wherever in the world you may be) then please contact me for further information (james.oliver@aht.org.uk).

Yours sincerely

James Oliver BVSc CertVOphthal DipECVO MRCVS
European Specialist in Veterinary Ophthalmology
## Dates for Your Diary 2014

<table>
<thead>
<tr>
<th>Event</th>
<th>Location</th>
<th>Dates</th>
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<tbody>
<tr>
<td>IEOC Symposium</td>
<td>Stresa, Italy</td>
<td>6-8 June 2014</td>
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<tr>
<td>SSVO/ESVO Conference</td>
<td>Malmo, Sweden</td>
<td>4-7 October 2014</td>
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<tr>
<td>ACVO Conference</td>
<td>Fort Worth, Texas</td>
<td>8-11 October 2014</td>
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<tr>
<td>BrAVO Winter meeting</td>
<td>Birmingham, UK</td>
<td>14-16 November 2014</td>
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### Winter Meeting 2014

**Neuro-Ophthalmology**

**Birmingham**  
November 14th—16th

Main Speaker: Jacques Penderis (University of Glasgow)
Chairperson and BSAVA liaison - Claudia Hartley
Claudia spent nine years in general practice and one year as a clinical scholar at Cambridge University studying dry eye in dogs. She completed a residency at the Animal Health Trust in Veterinary Ophthalmology and successfully passed her European Diploma exams in 2007. She currently works as head of the Ophthalmology unit at the Animal Health Trust and is undertaking clinical research on success rates of cataract and glaucoma surgeries in dogs, as well ocular disease in bears. As chairperson, Claudia oversees the running of the committee and chairs our meetings.

Secretary - Ida Gilbert
Ida graduated from Bristol Veterinary School in 1995. Following two years in mixed practice she decided to commit to her interests in ophthalmology and moved to Eastcott Veterinary Hospital in Swindon, where she gained her RCVS Certificate in Veterinary Ophthalmology in 2001. She enjoys all areas of Veterinary Ophthalmology and still works and lives in rural Wiltshire. As secretary, Ida is involved with enrolment of new members as well as dealing with general enquiries and helping herding the Committee members!

Conference coordinator and exhibitor liaison - Georgie Gent
Georgie graduated from Liverpool in 2005. She worked in small animal practice but had a keen interest in ophthalmology, resulting in her joining Robert Lowe at Optivet Referrals in 2008. Georgie gained her RCVS Certificate in Veterinary Ophthalmology in 2011 before moving to Davies Veterinary Specialists in March 2012 where she is undertaking an ECVO residency. Georgie researches venues for our conferences each year and is in charge of communicating with our sponsors.

Website and audiovisual - Tim Knott
Tim graduated with a honour degree in Anatomical Science from Bristol University in 1991, followed by his Veterinary degree in 1995. Tim holds the RCVS Certificate in Veterinary Ophthalmology and runs Rowe Referrals, Bristol. He is interested in all aspects of mixed practice but has special interests in ophthalmology, exotic animal medicine and surgery and fish disease. Tim is responsible for running the BRAVO website and also is involved with setting up the audiovisual facilities at each meeting.

Audiovisual - David Nutbrown-Hughes
After graduating from Bristol in 1995, David has worked in practices in Worcestershire, Somerset and West Sussex where he built on his interest in ophthalmology, gaining the RCVS Certificate in Veterinary Ophthalmology in 2004. Since June 2012 David has joined the ophthalmology team at Rowe Referrals, Bristol. David runs the audiovisual set-up at our meetings alongside Tim.

Scientific Programme Organizer - Alistair Oldfield
Having graduated in 1997 from Bristol University, Alistair joined Woodcroft Veterinary Group in June 2002 after working for nearly five years at the PDSA clinic in Manchester. Having attained his RCVS Certificate in Veterinary Ophthalmology, Alistair sees referral ophthalmology cases as well as continuing his work in general small animal practice. Alongside James Oliver, Alistair co-ordinates the scientific programme for each meeting and liaises with speakers.

Scientific Programme Organizer – James Oliver
Having graduated from the University of Bristol in 2002, James spent five years in general practice. James gained the RCVS Certificate in Veterinary Ophthalmology in 2007 and then undertook a three year clinical ophthalmology residency at Davies Veterinary Specialists. He holds the European Diploma in Veterinary Ophthalmology and has recently joined the team at the Animal Health Trust. Alongside Alistair, James works to attract conference speakers and assemble the scientific programme.

Clinical Auditor (new role) – Jenny Lambert
Jenny works at the Rosemary Lodge Veterinary Hospital as a Referral Veterinary Surgeon with a special interest in ophthalmology. She obtained the RCVS Certificate in Veterinary Ophthalmology in 2003. As clinical auditor, Jenny aims to create an ongoing cycle of continuous improvement, by collecting data and comparing current practice with evidence of good practice.

Editor – Natasha Mitchell
After graduating from University College Dublin in 1998, Natasha obtained an RCVS Certificate in Veterinary Ophthalmology in 2004 while working in West Sussex. She completed an alternative residency programme at the Eye Veterinary Clinic in Herefordshire and obtained the RCVS Diploma in Veterinary Ophthalmology in 2011. She runs a referral veterinary ophthalmology business in Limerick, Ireland. As Editor she is responsible for receiving abstracts and preparing the meeting proceedings.

Honorary Scientific Programme Organizer - David Gould
David graduated from the University of Edinburgh in 1992 and, after a period in general practice, completed a PhD at the University of Cambridge in the molecular genetics of inherited eye diseases of dogs. Following a three year clinical residency in Veterinary Ophthalmology at Bristol University Veterinary School, he was appointed Lecturer there in Veterinary Ophthalmology, a post that he held for three years before joining Davies Veterinary Specialists in 2003 where he runs their ophthalmology service. He holds both RCVS and European Diplomas in Veterinary Ophthalmology and is an RCVS Recognised Specialist in Veterinarian Ophthalmology and European Veterinary Specialist in Ophthalmology. David is staying on as an honorary member so we can still enjoy the advantages of his wisdom and extensive international contacts.
PROGRAMME

08:30-09:30  Registration / coffee
09:30-10:30  Phacoemulsification in dogs I - a two-part step-by-step dissection (Christine Heinrich/Heidi Featherstone)
10:30-11:15  Coffee and exhibition
11:15-12:15  Phacoemulsification in dogs II - a two-part step-by-step dissection (Christine Heinrich/Heidi Featherstone)
12:15-13:45  Lunch and exhibition
13:45-14:30  Phacoemulsification in man: Why we get complications in cataract surgery & how to minimize their incidence (Brian Little)
14:30-15:15  Phacoemulsification in man: Avoiding vitreous loss (Brian Little)
15:15-16:00  Coffee and exhibition
16:00-16:45  Phacoemulsification in man: Practical management of vitreous loss (Brian Little)
16:45  Close

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Please remember to visit our sponsors’ stands during the breaks

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