

OPHTHALMOLOGY

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MICHIGAN VETERINARY SPECIALISTS
PRESENTS:

TECHNIQUES
OF
OPHTHALMIC
EXAMINATION

Raymond J. Morreale, DVM, MS
Diplomate ACVO



Michigan Veterinary
Specialists

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Introduction

Welcome to Michigan Veterinary Specialists presentation of Techniques of Ophthalmic Examination. This manual is meant to provide you with all the techniques you will need to perform a good general ophthalmology examination on your patients.

This course will cover initial evaluation of the ophthalmology patient, diagnostic testing such as tonometry, Schirmer tear tests, fluorescein staining, cytology, and culture & sensitivity, use of a slit-lamp, and ophthalmoscopy. It will also cover appropriate care and maintenance of your equipment and this manual will provide you with resources for ophthalmic equipment as well as a list of ophthalmology texts.

As with anything, the more you do it, the better you will be at it, so try out these techniques on all your ophthalmology cases. As always, if you run into a problem, give us a call and we'll be happy to help you out.

Initial Evaluation of the Patient

2.1 Ophthalmic History

The importance of a good ophthalmic history cannot be overstated. Oftentimes, the signalment and a good history can help lead you to the diagnosis. Some important questions to ask in an ophthalmic examination include:

- Overall health of the pet
- Previous history of eye problems
- What is the current problem
- Duration of current problem
- Progression of current problem
- Has there been vision loss
- Difference in day vs. night vision
- Previous medical treatment
- Effect of medications
- Current medications (include all medications)

There are some important points to remember when you are taking your history. Don't forget about the signalment. Many problems have a predilection for a particular age or breed. Night vision loss is usually the result of retinal disease. It's also important to remember that systemic medications may have ophthalmic effects, for example, sulfa antibiotics and Etogesic can cause keratoconjunctivitis sicca, Baytril may cause retinal degeneration in cats, etc. It is important to glean this information out of the history.

2.2 Ophthalmic Examination

Your examination will actually begin as you are walking the patient back to the room and during your history. You should be observing the behavior of the dog for clues of visual dysfunction such as hanging its head low, hugging the wall or the owner's leg, or bumping into objects. Have the owner let the dog loose in the exam room and observe it while you obtain your history. Watch the dog negotiate in both photopic and scotopic conditions. You can set up obstacle and maze test them in these conditions.

It is important to observe the pet from a distance before you start the rest of your examination. Pay attention to eyelid position, patient comfort, and symmetry of the eyes and head. Once you begin touching the animal this evaluation may be

difficult, especially if the dog has repeatedly been treated for eye problems and he expects you to give him medications.

Begin by shining a light from a distance to get a tapetal reflection in both eyes at the same time. This is the best way to pick up anisocoria. After this perform an evaluation of direct pupillary light reflexes (PLR), consensual PLR's, and menace response. Remember that PLR's must be checked with a bright light source such as a Finhoff transilluminator. These tests are helpful, but it is important to remember that a positive PLR does not mean that an animal can see, a negative PLR does not mean an animal cannot see, and a negative menace response does not mean an animal cannot see. Check a palpebral reflex to make sure the pet can blink. A full neuro-ophthalmic exam will be covered in a later course.

You can also use your light at this time to look for the Sanson-Purkinje images. These are a series of three reflections; one off of the cornea, one off of the anterior lens capsule, and one off the posterior lens capsule. When you move your light, the reflection off the cornea and anterior lens capsule will move in the same direction, while the reflection off the posterior lens capsule will move in the opposite direction. These images are useful to locate the lens as well as to determine whether a lesion is in the lens or anterior chamber.

Check the globes for symmetry. Examine the eyelids for entropion or ectropion. Look for elevation of the nictitans. This is a passive structure in the dog and its elevation means that either the eye is enophthalmic (this may be mild), or there is a space occupying lesion behind the globe. If an eye appears exophthalmic, try to retropulse it back into the orbit. Make sure when you retropulse, that you perform this procedure on both eyes at the same time to notice subtle differences. Brachycephalic dogs have shallow orbits and may be difficult to retropulse normally. Retropulsion also allows you to evaluate the nictitans. After you have performed this initial scan, you are ready to begin diagnostic testing, followed by a magnified exam and ophthalmoscopy.

Diagnostic Testing

3.1 General

There are three diagnostic tests you should perform on every ophthalmic case you see. These are the Schirmer tear test, fluorescein staining, and tonometry. These will each be discussed separately in this section. In addition, this section will cover cytology and culture and sensitivity.

3.2 Schirmer Tear Test (STT)

This is a measurement of the animal's tear production. To perform the test, the notched end of a STT strip is placed into the ventral conjunctival cul-de-sac of each eye. Keeping the eyelid gently closed can help retain the strip in the cul-de-sac. After 1 minute, the strip is removed and the amount of wetting is measured in millimeters.

There are several brands of STT available. A newer brand of STT strips, put out by Schering Plough, have a scale printed on each strip and are impregnated with a blue dye for easier reading. If the tear production is high, the wetting may go further than the blue dye and the reading should be at the end of the wetting. Another brand called Sno Strips® are somewhat different and are not recommended. These strips get wider after a certain length which can affect the reading. Normal tear production should be greater than 15 mm in 1 minute.

3.3 Fluorescein Staining

Fluorescein is a water soluble dye that is repelled by the lipid-rich epithelial layer of the cornea. If there is a break in the epithelium, fluorescein will stain the corneal stroma. It can be seen in normal light but is enhanced by using a Cobalt blue filter. This is due to fluorescein's property of maximally absorbing light in the blue wavelength, then emitting it at a different wavelength in the green spectrum (fluorescing). Its high visibility and its poor ability to penetrate intact corneal epithelium make it a useful stain to look for corneal ulcers.

Fluorescein comes in several forms. It is manufactured as a topical drop which often has a topical anesthetic combined in it. One drop of this solution should be placed on the cornea of each eye. Fluorescein will also stain mucous, so after placing the drop the eye should be rinsed thoroughly with eye wash. The cornea should then be observed with a cobalt blue light for fluorescein retention. The topical drops are easier to administer, and by adding a topical anesthetic, you do not need to add an additional drop prior to tonometry. The drops should be

refrigerated when not in use to preserve their shelf life and the dropper tip should be kept sterile to avoid contamination of the bottle with bacteria.

Fluorescein is also available as dye-impregnated paper strips. The strip should be moistened and touched to the dorsal palpebral conjunctiva. Do not touch the strip to the cornea as this will result in a false positive result. You may also place a drop of saline on the strip and allow this to drop into the eye. The eye should then be rinsed as before. If a fluorescein strip is used, you will need to apply topical anesthetic prior to tonometry.

3.4 Tonometry

Tonometry is the measurement of the intraocular pressure. There are two types of tonometry commonly used in veterinary medicine. These are indentation tonometry and applanation tonometry. Each of these techniques will be described separately.

3.4.1 Indentation Tonometry

Indentation tonometry measures the force required to indent the cornea which gives an indirect reading of intraocular pressure. This is performed with a Schiötz tonometer. Although pressure readings with a Schiötz tonometer can be very accurate, it is much more difficult to use than a Tonopen. It must also be cleaned and dismantled after each use and therefore is quite time consuming.

The tonometer is assembled with the 5.5 g weight in place. After assembly, the instrument should be calibrated on the calibration button in the box. After installation of topical anesthetic, the animal's head should be restrained in a position with the nose up and the eyelid retracted with the eye facing upward. The foot plate of the tonometer should be placed on the cornea. With the collar held in a neutral position, the scale is read and compared with the conversion chart that comes with the tonometer. In the 1980's, conversion charts for dogs were published, however these may not be accurate, and the conversion chart that comes with the tonometer is recommended. An important point to remember is that the lower the reading on the tonometer scale, the higher the intraocular pressure is.

After use, the tonometer should be cleaned and dried with alcohol and pipe cleaners. This is important to do after each use in order to keep the shaft of the tonometer moving freely.

3.4.2 Applanation Tonometry

Applanation tonometry measures the force required to flatten an area of the cornea which gives an indirect reading of intraocular pressure. This is

performed with the Tonopen. When using the Tonopen, it is important to remember to use very light pressure and not to put any pressure on the globe. You do not need to indent the cornea as occurs with the Schiotz tonometer.

The Tonopen should be calibrated and the tip cover replaced daily. If the Tonopen does not appear to be working properly, it may be recalibrated. This is performed by holding the Tonopen with the tip down and pressing the button twice. The message window will read CAL. After a few moments the instrument will beep and the window will read up. Turn the tip upwards. The instrument will beep again and read “good” or “bad”. If it reads “bad”, the instrument cannot be used until it is calibrated again. The Tonopen should be calibrated until it reads “good” twice in a row.

When using the Tonopen, it should be turned on by pressing the button once. The instrument will beep and there will be a double dashed line in the message window. The instrument is now ready to take readings. After topical anesthetic and gentle eyelid retraction, the tip should be gently tapped against the central cornea. You do not need to indent the cornea, but the tip needs to be pressed flat against the surface. You will hear a series of clicks and then a louder beep. Each time the instrument clicks, it is taking a reading. The beep is the final average of these readings. After the beep, you will see a number in the message window and a dash below it. The dash should be all the way to the right over the 5% which means that your readings are close together. The number is the intraocular pressure in mmHg. Normal intraocular pressure with a Tonopen is typically 10-20 mmHg. The Tonopen turns off by itself.

3.4.3 Rebound Tonometry

A new type of rebound tonometer has recently become available on the veterinary market. Rebound tonometry utilizes a pair of coils coaxial with a probe shaft that are used to propel a lightweight magnetized probe toward the cornea and to sense its movement. Movement of the probe is initiated by a pulse of electrical current which induces a magnetic field within the solenoid coil and the inverse of deceleration time (deceleration time⁻¹), which is the parameter most closely correlated to IOP, is monitored by the sensing coil. At this time, it is still unclear whether this type of tonometry will be as accurate as applanation tonometry which is still favored by most veterinary ophthalmologists.

3.5 Cytology

Another important corneal diagnostic test is cytology. Removal of some cells from the diseased cornea can give invaluable information for diagnosis and treatment. It is used for non-ulcerative surface disease, such as feline eosinophilic

keratitis, as well as for deep or progressive corneal ulceration. It should be combined with culture and sensitivity with corneal ulceration as the cytology may give immediate direction to proper treatment. Additional tests such as PCR for feline herpesvirus can be performed on cells collected for cytology.

Cytology is best performed with a Kimura spatula or a cytobrush. A study that compared the effectiveness of cytology with swabs, spatulas, and cytobrushes found that the spatula and cytobrush were superior in their cell collection ability. Although the cells collected with a swab had good cellular detail, there were too few to be diagnostic. The spatula will obtain the largest amount of cells but may destroy some of cellular structure. The cytobrush may be superior in that it collects an intermediate number of cells and provides good cellular detail. The blunt end of a scalpel blade can be used as a makeshift spatula if one is not available.

After instillation of topical anesthetic, the eyelids are gently retracted and the area of interest is scraped lightly with the spatula. The cells are then gently spread onto a microscope slide. Do not spread the cells over too large an area. In the case of the cytobrush, the brush is rolled over the area of interest and rolled onto the slide. This helps preserve cellular detail. After slide fixation, generally with heat or acetone, the slides are usually stained with a Gram stain or modified Wright-Giemsa stain. The Gram stain will allow better evaluation of organisms and will help provide guidance for antibiotic treatment, whereas the modified Wright-Giemsa stain will provide better cellular details. The slide can also be submitted to a laboratory for special staining techniques should these be required. It is best to make at least 2 slides, one to examine and one to leave unstained for a laboratory should this be required.

3.6 Culture and Sensitivity

The diagnosis of infectious keratitis and corneal ulceration are aided by the use of corneal culture and sensitivity. Culture and sensitivity are indicated in all cases of corneal ulceration involving the stroma. This will allow better selection of antibiotic therapy. In dogs and cats, fungal corneal infections are quite rare in contrast to horses and unless cytology dictates otherwise, bacterial culture is sufficient. In addition, corneal infections in the dog and cat are usually due to aerobic bacteria and anaerobic culture is typically not performed.

When performing a culture, better bacterial yield can be achieved by pre-wetting the swab. Dacron tipped swabs should be used and the pre-wetting can be achieved by breaking the transporting broth medium container prior to removing the swab or by using sterile saline. Ideally, culture should be performed prior to putting any medications including topical anesthetic onto the eye as they may inhibit bacterial growth. One study has shown, however, that one application of topical anesthetic does not significantly affect culture results. The eyelids should

be gently retracted and the swab should be applied to the area of ulceration. It should be attempted to apply all sides of the swab to the corneal ulcer. The side of the swab should be used instead of the tip as the sides are what are applied to the culture medium when the swab is plated out. Great care should be taken to avoid touching the eyelid margins with the swab. The swab is then submitted to a laboratory for aerobic culture and sensitivity. If fungal culture is to be performed, it may be submitted on the same swab.

There has been some argument as to whether or not bacterial sensitivities are useful. The con argument is that the antibiotic discs that are used for sensitivity testing do not reach the same concentration that can be achieved with topical application of antibiotics. It is still reasonable to use an antibiotic that the organism is susceptible to in order to best treat the infection.

Another important point to consider when performing a culture is that there is a normal bacterial and fungal flora for the cornea and conjunctiva. This pattern can change seasonally and regionally and it is important to know whether a particular result is a pathogen or a contaminant. The most common bacterial isolates from infected ulcers are *Pseudomonas* spp. and *Staphylococcus aureus*.

Slit-Lamp Examination

4.1 General

The slit-lamp performs 2 major functions. Firstly, it provides magnification to get a more detailed examination of the eye. This will be the most important function for you until you become proficient with the instrument. The second function makes use of the slit beam. By decreasing the beam of light to a slit, a cross-section of the eye is obtained. This allows location of the depth of lesions and allows visualization of mild changes that could not be seen with the full illumination. This takes a significant amount of practice. Initially, you should use a wide slit beam as this will be easier for you. As you become more proficient, you can decrease the slit size. The smaller slit sizes will give you a better cross-section, but are more difficult to use. You can use the slit-lamp to examine the eyelids and ocular adnexa, conjunctiva, cornea, anterior chamber, iris, lens, and anterior vitreous.

4.2 Slit-Lamp Models

There are several slit-lamp models for you to choose from. In its simplest form, a slit-lamp consists of a light source and magnification. The Eidolon hand held slit-lamp is a cost effective version of this. There is a slit beam light source and a magnifying lens that you look through. Heine also makes a small hand held slit-lamp that fits onto either a Welch-Allyn or Heine handpiece. This Heine instrument is slightly more sophisticated in that you can vary the slit beam size. The more expensive models such as the Kowa SL-14, Kowa SL-15, and Zeiss HSO 10, use a series of magnifying lenses to allow variable magnification, as well as increased light variability.

4.3 Slit-Lamp Use

The slit-lamp provides magnification as well as a cross-sectional view of the eye. It is used to examine the eyelids and ocular adnexa, conjunctiva, cornea, anterior chamber, iris, lens, and anterior vitreous. The full circle light is used for magnification purposes only and the slit provides a cross-section. If you are using a slit-lamp that has adjustable magnification it is important to remember that the higher the magnification you are using, the shallower your depth of field will be. This means that you have only a small distance that you can move and stay in focus. If you are having a hard time keeping focused, make sure that the magnification is turned down to the lowest level.

It is important to develop a systemic approach to slit-lamp examination of the eye so that lesions are not missed. One of the more common approaches is to move from superficial to deep. First the eyelids and adnexa are examined followed by cornea and conjunctiva, anterior chamber, iris, lens, and finally anterior vitreous. If you begin the exam by jumping to an obvious lesion, other lesions are often missed. Administration of topical 1% tropicamide will aid in examination of the lens and vitreous as well as evaluation of the retina with ophthalmoscopy.

There are several types of illumination you will use in a slit-lamp exam, often without realizing you are doing it. Understanding and purposely using the different types of illumination will improve your ability to detect lesions. The types of illumination you will use most commonly are diffuse direct illumination, focal direct illumination, direct retroillumination, indirect retroillumination, and proximal illumination.

Diffuse direct illumination is performed using a penlight or the slit-lamp with a full circle of light. With this you examine the eyelids, cornea, conjunctiva, and iris for gross defects. Focal direct illumination is then used by looking through the oculars and decreasing the slit size. As you decrease the slit size, you will begin to see a three-dimensional cross-section of the cornea called a parallelepiped. This allows examination of the full-thickness of the cornea. As you further reduce the slit size, you will get a two-dimensional cross-section called an optic section. This allows you to determine depth of lesions in the cornea and lens. It is also the best way to observe aqueous flare. In normal circumstances, you should not see the light beam between the cornea and the lens. Aqueous flare produces an effect like headlights in fog allowing the light to be seen coursing through the anterior chamber.

Direct and indirect retroillumination are fairly similar. They use light that is reflected off of the iris or fundus to illuminate lesions from behind. The difference is in the angle that you are viewing the reflected light from. With direct, you are viewing the light from the angle of reflection and with indirect you are viewing from a different angle. This type of illumination allows you to pick up more subtle lesions that may be missed with direct illumination. This is a good way to pick up keratic precipitates, iris atrophy, incipient cataracts, and nuclear sclerosis.

Proximal illumination is used to pick up very subtle lesions of the cornea. The light beam is placed next to the lesion and the light is allowed to transilluminate through the lesion. This technique is good for picking up subtle dystrophies of the cornea.

Slit-lamp examination is a difficult technique to master. Although it takes a lot of practice to be good, the use of a slit-lamp will greatly benefit your ophthalmic examination.

Ophthalmoscopy

5.1 General

Ophthalmoscopy allows visualization of the ocular fundus. This includes components of the optic nerve head, retinal blood vessels, retina, choroid, and occasionally sclera. Installation of 1% tropicamide will aid visualization. We will discuss three types of ophthalmoscopy in this section; direct ophthalmoscopy, binocular indirect ophthalmoscopy, and monocular indirect ophthalmoscopy. Determination of what is normal and abnormal in an ophthalmoscopic exam takes lots of practice and will be covered in detail in the next course.

5.2 Direct Ophthalmoscopy

There are many different models of direct ophthalmoscopes available. They all contain a light source and a series of lenses that are changed using a dial. The numbers on this dial are the diopter power of the lens you have selected. Red numbers are negative diopter lenses which will increase your focus into the eye and positive diopter lenses which will decrease your focus into the eye have green or black numbers. Most models will have another dial which modifies the light source. Common modifications include large and small spot sizes, slit light, graticule, red-free filter, and cobalt blue filter.

Direct ophthalmoscopy must be performed with the observer in close proximity to the eye (2-3 cm). The animals left eye should be observed with your left eye and the right eye should be examined with your right eye. This will distance you as much as possible from your patients mouth. For most people, the retina will be in focus with a diopter setting of 0 to -4. Direct ophthalmoscopy provides high magnification (~17 times in the dog and ~19 times in the cat). Due to this degree of magnification, only a small amount of the fundus can be visualized at a time. Begin by observing the optic nerve head and then systematically cover the quadrants of the fundus.

The advantage of the direct ophthalmoscope is the amount of magnification you are able to achieve. The equipment is also relatively inexpensive. Unfortunately, the high magnification comes with the drawback of a very small field of view. There is also no stereopsis, however, by changing the diopter power of the lens you are using you can determine how depressed or raised a lesion is. Another disadvantage to this system is the proximity of your face to the patients mouth when performing this procedure.

5.3 Binocular Indirect Ophthalmoscopy

Binocular indirect ophthalmoscopy is performed with an binocular indirect ophthalmoscope or BIO. There are several different makes of BIO's available. Although they vary in their position, they have the same basic controls. The eyepieces adjust for the interpupillary distance. There is a lever that changes the spot size of the light, and there is a lever that changes the light color. It varies through white, cobalt blue, and green (no red filter). Some have a yellow filter to decrease retinal damage.

Binocular indirect ophthalmoscopy also utilizes a hand held lens. These lenses typically vary in diopter power from 14-40 D. Magnification with indirect ophthalmoscopy varies with lens power and species but typically ranges from 3-5 times. The higher the diopter power of your lens, the less magnification you will have and the wider field of view you will have. It is often easiest for the beginner to start off with a 28 or 30 D lens. Another important point is that everything you see with this procedure will be upside-down and backwards. You will need to reverse this in your head to understand what you're seeing.

Binocular indirect ophthalmoscopy is performed with the patient at arms length. One hand should be used to hold the muzzle and the other should hold the lens. After looking at the patient with the headset and getting a fundic reflection, the lens should be placed in the light beam path 2-4 cm in front of the eye. The lens should be moved toward or away from the eye in order to obtain a full view of the fundus. You should then move your body and the dogs head to examine all areas of the fundus.

Advantages of binocular indirect ophthalmoscopy include a much wider field of view than can be obtained with direct ophthalmoscopy. This method also provides stereopsis so that lesions can be visualized three-dimensionally. You are also in a safer position from the animal's mouth. The main disadvantages of the procedure are that it is initially harder to learn and the equipment is more expensive.

5.4 Monocular Indirect Ophthalmoscopy

Welch-Allyn manufactures a Pan-Optic monocular indirect ophthalmoscope. This scope has the advantage of being simple to use as well as a view of the fundus that is 5 times larger than a direct ophthalmoscope. The scope hooks onto a standard Welch-Allen battery pack hand set. It will work best if the Lithium-Ion battery source is used. The aperture setting should be on the standard setting, and you should focus on an object 10-15 ft away. After focusing, the eye cup should be placed against the animal's brow and you can observe the fundus through the observer aperture.

Information and Supply Sources

6.1 Recommended Ophthalmology Texts

The following is a list of ophthalmology textbooks that are currently being produced. Contact the publisher or your local book representative to order.

- Veterinary Ophthalmology, 3rd Ed., Gelatt, 1999, Lippincott Williams & Wilkins. – This is the current favorite of most veterinary ophthalmologists. It is the most complete text, but is somewhat costly. There should be a new edition coming out soon.
- Fundamentals of Veterinary Ophthalmology, 3rd Ed., Slatter, 2001, WB Saunders. – This is a decent second choice book. One of the most common books used in veterinary school courses. Less detail than Gelatt.
- Ophthalmic Disease in Veterinary Medicine, Martin, 2005, Manson. – This is also a good second choice, especially as Gelatt is not available. It is quite new and has excellent pictures as well as text. It is put out by a smaller publishing company and the best way to get it is likely online.
- Essentials of Veterinary Ophthalmology, Gelatt, 2000, Lippincott Williams & Wilkins. – This is also a decent second choice book. This is the condensed form of the main textbook. It has very nice tables, but goes into less detail than the main text. Some of the less common diseases are skipped altogether.
- Small Animal Ophthalmology Secrets, Riis, 2002, Hanley & Belfus. – This is a book from the series of “Secrets” books. Certainly not a complete textbook, but good reviews for most of the common things.
- Small Animal Ophthalmology, 3rd Ed., Peiffer & Petersen-Jones, 2000, Saunders. – This is a nice little book. Not as in depth and covers only dogs and cats.
- Veterinary Ophthalmology Essentials, Grahn, Cullen, & Peiffer, 2004, Butterworth Heinemann. – This is a nice little review book. It doesn't have many good pictures, but it does come with a nice problem oriented CD Rom.
- Equine Ophthalmology, Gilger, 2005, Elsevier Saunders. – This is an excellent text for equine practitioners. It is complete, up to date, and has great pictures.

6.2 Recommended Ophthalmology Atlases

Ophthalmology is a highly visual specialty and having an atlas, which is basically just a picture book, can come in very helpful. The following is a list of veterinary ophthalmology atlases which are currently available.

- Color Atlas of Veterinary Ophthalmology, Gelatt, 2001, Lippincott Williams & Wilkins. – This is a nice all-purpose atlas. The pictures are better in some of the other books, but this appears to be the most complete atlas available at this time.
- Color Atlas of Canine and Feline Ophthalmology, Dziezyc & Millichamp, 2004, Elsevier Saunders. – This is a good, fairly new atlas with lots of good pictures.
- Veterinary Ophthalmology, Barnett, 1996, Mosby-Wolfe. – This is another good all-purpose atlas.
- Diagnostic Atlas of Veterinary Ophthalmology, Barnett, 2006, Mosby/Elsevier. – This book is a new edition of the older Barnett atlas and should be available this month.
- Atlas of Feline Ophthalmology, Ketring & Glaze, 1994, Veterinary Learning Systems. – This is a spiral bound book with fantastic pictures. It is limited in that it only covers cats.
- Atlas of Breed-Related Canine Ocular Disorders, Ketring & Glaze, 1998, Veterinary Learning Systems. – This is another spiral bound book with fantastic pictures. It is limited in that it only covers canine breed-related disorders.
- Canine Ophthalmology, Barnett, Sansom, & Heinrich, 2002, Saunders. – Although technically a text and atlas, the main purpose of this book is as an atlas. Very good pictures, but only covers dogs.
- Feline Ophthalmology, Barnett & Crispin, 1998, Saunders. – Also an atlas and text. Very nice pictures, but only covers cats.

6.3 Ophthalmology Informational Websites

The following websites may be useful for ophthalmology information:

- www.ACVO.com
Official website of ACVO
- www.ARVO.org
Website for the Association for Research in Vision and Ophthalmology
- www.ASVO.org
Website for the American Society of Veterinary Ophthalmology
- <http://www.eyevet.info/infocentre.html>
The Veterinary Ophthalmology Information Centre which has many continuing education files
- www.mammaleye.com
A site devoted to clinical and scientific ophthalmology
- www.michvet.com
The official website for Michigan Veterinary Specialists. Our site is expanding it's information section for clients as well as referring veterinarians.

- <http://www.vet.perdue.edu/~yshen/cerf.html>
The website for the Canine Eye Registration Foundation

6.4 Ophthalmology Producers and Distributers Websites

The following is a list of websites which produce and sell ophthalmic equipment. Some of the large companies require purchase of equipment through a distributor instead of direct sale.

- www.heine.com
Heine sells a small hand held slit-lamp (HSL 150) as well as BIO's, direct ophthalmoscopes, and other equipment for the veterinary as well as human market.
- www.danscottandassociates.com
Dan Scott & Associates are the veterinary distributor for the tonopen. They also sell the Eidolon slit-lamp, Kowa slit-lamps, Keeler BIO's, Volk lenses, and a wide variety of monitoring equipment. Dan Scott and his son Chris are always very helpful and excellent to do business with.
- www.kowa.com
Kowa sells excellent slit-lamps and other ophthalmic equipment. Dan Scott & Associates is a distributor for these slit-lamps.
- www.volkstore.com
Volk sells lenses for indirect ophthalmoscopy, gonioscopy, and other ophthalmic procedures. These lenses can be purchased through Dan Scott & Associates.
- www.welchallyn.com
You are probably already familiar with Welch-Allyn. They produce direct ophthalmoscopes, a BIO, the Pan-Optic monocular indirect ophthalmoscope, and a wide variety of ophthalmic and general medical equipment.
- www.zeiss.com/us
Zeiss produces the HSO 10 hand held slit-lamp as well as excellent lens loupes and other ophthalmic equipment.

Glossary

The following list of commonly used ophthalmology terms is adapted from the Ohio State University, Ophthalmology class notes.

Common Root Words

Blepharo-	Eyelid
Cor-	Pupil
Cyclo-	Ciliary Body
Dacryo-	Tears, Lacrimation
Hyal-	Vitreous
Hyp-	Anterior Chamber
Irido-	Iris
Kerato-	Cornea
Ophthalm-	Globe, Eye
Papilla-	Optic Disc
Phako-	Lens
Tarso-	Eyelid

ABIOTROPHY: Trophic failure, presenile tissue degeneration. Usually used to describe retinal atrophies.

ABLATION: Removal of part of the body.

ACCOMMODATION: Change in the degree of biconvexity of the lens to adjust the eye for seeing at different distances (poorly developed in animals).

ADNEXA: Appendages of the eye (eyelids, conjunctiva, extraocular muscles, orbital contents).

AGENESIS: Developmental absence of any body part.

AMAUROSIS: Blindness, especially that occurring without apparent change in the eye itself.

ANIRIDIA: Absence of the iris.

ANISOCORIA: Unequal pupil size.

ANKYLOBLEPHARON: Adhesion of eyelids to each other (normal at birth in dog and cat).

ANOPHTHALMIA (anophthalmos): Total failure of the eye to develop (much rarer than microphthalmia).

ANTERIOR CHAMBER: Space filled with aqueous, bordered anteriorly by the cornea and posteriorly by the iris and lens.

ANTERIOR CHAMBER ANGLE: Angle between the iris and corneosclera through which aqueous humor leaves the eye (also called the irido-corneal angle or drainage angle).

ANTERIOR SEGMENT: Anterior portion of the globe (cornea, iris, lens, anterior and posterior chambers, anterior sclera).

ANTERIOR UVEITIS (iridocyclitis): Inflammation of the iris and ciliary body.

APHAKIA: Absence of the lens.

AQUEOUS FLARE: Visualization of a beam of light as it passes through, usually transparent, aqueous of the anterior chamber; seen with an increase in protein or cellular content as a result of uveitis (Tyndall effect).

AQUEOUS HUMOR: Clear fluid filling the anterior and posterior chambers.

ASTEROID HYALOSIS: Spherical and stellate opacities in the vitreous composed of calcium phospholipids. This is a degenerative disease.

ASTIGMATISM: Spherical refractive error which prevents the light rays from coming to a single focus on the retina because of different degrees of refraction in the various meridians of the cornea or lens.

BERGMEISTER'S PAPILLA: The remnant of the hyaloid stalk of the optic disc.

BIOMICROSCOPE: Slit lamp, an instrument providing magnification and well focused illumination for eye examination.

BLEPHARITIS: Inflammation of the eyelid.

BLEPHAROCHALASIS: Redundancy of the upper eyelid.

BLEPHAROPHIMOSIS: Inability to open eye to normal extent (similar to ptosis).

BLEPHAROSPASM: Spasmodic blinking, spastic contraction of the orbicularis oculi muscle. Often indicates pain.

BLIND SPOT: Small non-visual area of the visual field corresponding to the optic disc since there are no photoreceptors in this area.

BLOOD-AQUEOUS BARRIER: Functional barrier between the vascular system and the aqueous system; consists of the tight junctions of the ciliary epithelium and endothelial cells of the iridal vessels.

BULBAR: Pertaining to the globe of the eye as a whole.

BUPHTHALMOS (Cow-eyed): Enlargement of the eye due to glaucoma.

CANALICULUS (lacrimal): A small canal beginning at the lacrimal punctum in the medial margin of each eyelid, running transversely medially to empty with its counterpart into the lacrimal sac.

CANTHOPLASTY: Reconstructive surgery on the canthus.

CANTHOTOMY: Incision of the canthus to widen the palpebral fissures.

CANTHUS: The outer or inner angle between the eyelids, where upper and lower lids join.

CATARACT: Any opacity of the lens.

CHALAZION: A cystic dilatation or granuloma of the tarsal glands (Meibomian glands) which lie in the tarsal plate.

CHEMOSIS: Edema of the conjunctiva.

CHORIORETINITIS: Inflammation of the choroid and retina.

CHORISTOMA: A mass of tissue that is normal histologically but located in an abnormal site. e.g. dermoid.

CILIARY FLUSH: Hyperemia of the bulbar conjunctiva usually associated with intraocular inflammations.

CLOQUET'S CANAL: Potential space passing through the middle of the vitreous from the optic disc to the lens; the hyaloid canal. It represents the remnant of the primary vitreous space.

COLOBOMA: Any notch-like defect in the eye or eyelids; usually refers to a congenital defect.

CONES: Retinal cells which are responsible for vision in bright light.

CONJUNCTIVA: The mucous membrane lining the back of the eyelids (palpebral) and the front of the eye (bulbar) except for the cornea.

CONJUNCTIVITIS: Inflammation of the conjunctiva.

CORECTOPIA: Abnormal position of the pupil.

CORNEAL DYSTROPHY: Corneal degeneration; used more broadly in veterinary medicine than in human ophthalmology.

CORPORA NIGRUM: Cystic prominences of the posterior pigment epithelial layers of the iris which have extended around the pupillary edge of the iris. It is more common in herbivores and more prominent on the dorsal pupil margin. Also known as granula iridica.

CUL-DE-SAC: The fold between the conjunctival layers covering the lid and the eyeball.

CYCLITIC MEMBRANE: Membrane formed along the plane of the anterior vitreous face, anchored on each side at the pars plana. It originates from cells in the adjacent ciliary body and retina. Common following cataract surgery.

CYCLITIS: Inflammation of the ciliary body.

CYCLOCRYOTHERAPY: Freezing of the ciliary body and processes; used for treatment of glaucoma.

CYCLODIALYSIS: Antiglaucoma operation which separates ciliary body from sclera to establish an alternative drainage pathway for aqueous.

CYCLOPHOTOCOAGULATION: Use of laser energy to coagulate ciliary epithelium; used for treatment of glaucoma.

CYCLOPLEGIA: Paralysis of the ciliary muscle, resulting in loss of accommodation.

CYCLOPLEGIC: Drug producing cycloplegia. (all cycloplegics are mydriatics; not all mydriatics are cycloplegics)

DACRYOADENITIS: Inflammation of the lacrimal gland.

DACRYOCYSTITIS: Inflammation of the lacrimal sac.

DACRYOCYSTORHINOGRAPHY: Radiocontrast study of the nasolacrimal apparatus.

DARK ADAPTATION: The ability of the retina and pupil (iris) to adjust to decreased illumination.

DERMOID: Skin-like tumor of the cornea and conjunctiva; (a type of choristoma).

DESCEMETOCELE: A stromal ulcer deep enough to expose Descemet's membrane.

DETURGESCENCE: Normal state of corneal hydration. Loss of deturgescence results in edema.

DISC (DISK): Optic nerve head (papilla); the intraocular portion of the optic nerve.

DIOPTER: The unit in which the refracting strength of a lens is measured.

DIPLOPIA: Seeing one object as two, double vision.

DISTICHIASIS: An abnormal row of eyelashes arising from the Meibomian gland orifices, individual lashes are termed distichia.

DYSTROPHY (Corneal): Opacities of the cornea related to a defect in metabolism.

ECTASIA: Dilatation, distention; usually pertaining to cornea or sclera and resulting from acquired weakness or congenital malformation.

ECTOPIC CILIA: An abnormal hair which grow through the surface of the palpebral conjunctiva.

ECTROPION: Eversion of the eyelids, drooping away from normal contact with the cornea.

ELECTRORETINOGRAPHY (ERG): Recording of the retinal electrical potentials generated by flashes of light.

EMMETROPIA: Refractive condition of the normal eye such that images focus on the retina.

ENDOPHTHALMITIS: Inflammation of the interior of the eye.

ENOPHTHALMOS: Recession of the eyeball into the orbit.

ENTROPION: Inversion of the free eyelid margin.

ENUCLEATION: Removal of the entire globe leaving the eye muscles and other orbital tissue in place.

EPIPHORA: Overflow of tears.

EQUINE RECURRENT UVEITIS (ERU): Recurrent iridocyclitis of horses (also called moon blindness).

ESOTROPIA: Inward (medial) deviation of the eye.

EURYBLEPHARON: Excessive length of the palpebral fissure.

EVISCERATION: Removal of the internal contents of the eye with retention of the cornea and sclera.

EXENTERATION: Removal of all soft tissue within the bony orbit.

EXOPHTHALMOS: Protrusion of the eyeball.

EXOTROPIA: Lateral deviation of the eyeball; divergent strabismus.

FLARE: Increased protein content of aqueous resulting in the Tyndall effect. Flare indicates breakdown of the blood aqueous barrier (uveitis).

FLOATERS: Particles in the vitreous which cast shadows onto the retina.

FLUORESCEIN: Water soluble dye which fluoresces green, particularly with blue illumination. It is used topically to detect corneal epithelial defects and intravenously to evaluate chorioretinal circulation or integrity of blood-aqueous or blood-retinal barriers.

FORNIX: The reflection of the conjunctiva from the eyelid or nictitating membrane to the globe.

FOVEA: The small depression in the macula (of the retina) adapted for the most acute vision in many primates and birds.

FUNDUS: The inside of the eye, particularly the retina, optic disc, and retinal vessels, that can be seen with an ophthalmoscope.

GLAUCOMA: Intraocular pressure exceeding physiologic limits.

GONIOSCOPY: Examination of the iridocorneal angle with the aid of a special lens which counteracts the refractive curvature of the cornea.

HAMARTOMA: Abnormal growth or malformation of tissue normally found in that location.

HAW: Lay term for the nictitating membrane.

HEMERALOPIA: Day blindness.

HEMIANOPIA: Loss of half the visual field.

HETEROCHROMIA: Different colored irides (anisochromia).

HIPPUS: Spasmodic, rhythmic movements of the pupil, independent of illumination.

HORDEOLUM: A sty or inflammation of the sebaceous gland or the eyelash (cilia) follicle.

HORNER'S SYNDROME: Sympathetic nerve paralysis characterized by miosis, ptosis, enophthalmos, protrusion of the nictitating membrane, and ipsilateral sweating in animals with the ability to sweat.

HYALITIS: Inflammation of the vitreous.

HYALOSIS: Degeneration of the vitreous.

HYDROPTHALMOS: Congenital glaucoma.

HYPEROPIA: Refractive error in which the focal point of light rays is behind the retina (farsightedness).

HYPERTROPIA: Upward deviation of the eye.

HYPHEMA: Blood in the anterior chamber.

HYPOPYON: Pus in the anterior chamber.

HYPOTONY: Reduced intraocular pressure.

INTUMESCENCE: Swelling of the lens due to imbibition of water.

IRIDECTOMY: Surgical excision of iris tissue.

IRIDOCYCLITIS: Inflammation of the iris and ciliary body.

IRIDODONESIS: Trembling of the iris with eye movements indicating loss of the support of the lens/zonule diaphragm.

IRIDOTOMY: Incision of the iris.

IRIS BOMBE: Synechiae of the posterior surface of the iris to the anterior lens capsule so that the aqueous is trapped in the posterior chamber causing the iris to balloon forward, often blocking the drainage angle.

KERATECTOMY: Excision of part of all of the cornea.

KERATIC PRECIPITATE (KP): Aggregate of inflammatory cells on corneal endothelium, indicating uveitis.

KERATITIS: Inflammation of the cornea.

KERATOCONJUNCTIVITIS SICCA (KCS): Dry eye, usually as a result of lacrimal gland dysfunction or inadequate distribution of tear film.

KERATOCONUS: Conical protrusion of the cornea.

KERATOMYCOSIS: Fungal infection of the cornea.

KERATOMALACIA: Severe corneal necrosis resulting from collagenase, protease, and hydrolase enzymatic activity. Common with *Pseudomonas*, *Strep.*, and mycotic infections and with alkali burns.

KERATOPLASTY: Corneal grafting.

LACRIMATON: Tear production.

LAGOPHTHALMOS: Inadequate eyelid closure.

LENTICONUS: Conical projection of the anterior or posterior surface of the lens.

LENTICULAR: Pertaining to the lens.

LENTICULAR SCLEROSIS (nuclear sclerosis): Aging change within the lens resulting from continual growth and compaction of the lens nuclei.

LEUKOMA: A dense, white, opaque scar. (Adherent leukoma denotes a scar of the cornea incorporating the iris).

LIMBUS: Junction of the cornea and sclera.

MACULA: A small spot, 1) a moderate corneal opacity, 2) central area in some primate and avian retinas.

MEGALOCORNEA: Congenitally large cornea which may be confused with congenital glaucoma.

MEIBOMIAN GLANDS: Modified sebaceous glands of the upper and lower tarsal margin. Excretory ducts form the "gray line" of the eyelid margin.

MICROCORNEA: Small or hypoplastic cornea.

MICROPHTHALMIA: Congenitally small eyeball.

MIOSIS: Constriction of the pupil.

MIOTIC: n. drug which causes constriction of the pupil. adj. A small pupil.

MITTENDORF'S DOT: The remnant of the anterior hyaloid in the region of the posterior pole of the lens capsule.

MORGAGNIAN CATARACT: A hypermature, partially liquified cataract.

MYDRIASIS: Dilation of the pupil.

MYDRIATIC: n. Drug which causes the pupil to dilate. adj. Term to describe a dilated pupil.

MYOPIA: Refractive error in which the point of focus of the eye is in front of the retina (nearsightedness).

NEBULA: Minor corneal opacity.

NEVUS: Focal pigmented area in the iris, choroid, etc.

NYCTALOPIA: Night blindness.

NYSTAGMUS: Involuntary oscillation of the eyeballs. It implies a vestibular or vision deficit.

O.D. (oculus dexter): Right eye.

O.S. (oculus sinister): Left eye.

O.U. (oculi uterque): Both eyes.

PALPEBRAL: Pertaining to the eyelid.

PANNUS: Subepithelial proliferation, pigmentation, and vascularization of the cornea.

PANOPHTHALMITIS: Inflammation involving all tunics of the eye.

PAPILLA: Optic disc.

PAPILLEDEMA: Edema of the optic disc (papilla).

PAPILLITIS: Inflammation of the optic disc.

PENETRATING: A wound going completely through an ocular structure.

PHOTOPHOBIA: Abnormal sensitivity to or discomfort from light.

PHOTORECEPTORS: Rods and cones; retinal cells which convert photic energy into electrical impulses.

PHTHISIS BULBI: Shrinking of the eyeball; small shrunken eyeball following inflammation.

PHOTOPIC: Relating to or being vision in bright light with light-adapted eyes that is mediated by the cones of the retina.

PLASMOID AQUEOUS: Fibrin in the anterior chamber.

POSTERIOR CHAMBER: Space between the posterior surface of the iris and the anterior surface of the lens; filled with aqueous.

POSTERIOR SEGMENT: Portion of the eye posterior to the lens.

PRESBYOPIA: Loss of accommodation in advancing age due to compaction of the lens material.

PROPTOSIS: Anterior displacement of the globe; usually traumatic.

PTERYGIUM: Triangular thickening of the bulbar conjunctiva advancing onto the cornea with the apex toward the center of the cornea. Rare in animals.

PTOSIS: Drooping of the eyelid; usually refers to the upper eyelid.

PUPIL: Opening in the axial iris.

PUPIL OCCLUSION: Obstruction of the pupil to obstruct aqueous flow.

PUPIL SECLUSION: Complete posterior synechiae restricting movement of the pupil; may lead to iris bombe.

REFRACTION: 1) Deviation in the course of rays of light in passing from one transparent medium into another of different density. 2) Determination of refractive errors of the eye and correction by various lenses.

REFRACTIVE ERROR: Deviation from emmetropia.

REFRACTIVE MEDIA: The transparent parts of the eye having refractive power either by their density or their curvature.

RETINOSCOPE: Instrument for the objective determination of refractive error.

RETROILLUMINATION: Illuminating from behind by reflecting light from a deeper structure. Useful in evaluating the transparent media of the eye.

RODS: Retinal cells which are responsible for vision in dim light.

RUBEOSIS IRIDES: Neovascularization of the iris stroma; may be seen with anterior uveitis, especially if chronic.

SCLEROTOMY: Incision of the sclera.

SCOTOMA: A blind or partially blind area in the visual field.

SCOTOPIC: Relating to or being vision in dim light with dark-adapted eyes which involves only the retinal rods as light receptors.

SICCA: Dry; usually used to describe keratitis.

STAPHYLOMA: A bulging defect of cornea or sclera lined with uveal tissue.

STARS OF WINSLOW: End-on view of small choroidal vessels perforating the tapetum to connect deeper choroid vessels to the choriocapillaris, seen as a mosaic or regularly spaced minute dark foci. Most prominent in herbivores.

STEREOPSIS: Binocular vision, seeing three dimensions, giving depth perception.

STRABISMUS: Deviation of the eye(s); termed lateral, medial, ventral or dorsal, unilateral or bilateral; converging or diverging.

STRIATE KETATOPATHY: Irregular, linear opacities in the cornea usually associated with changes in Descemet's membrane. Seen in glaucoma (breaking) and phthisis bulbus (folding).

SYMBLEPHARON: Abnormal adhesions of the conjunctiva, often affecting eyelid structure.

SYNECHIA: An inflammatory adhesion of the iris to the lens (posterior synechia) or cornea (anterior synechia).

SYNERESIS: The process of liquefaction of the vitreous with separation of fluid and contraction of the gel component.

TAPETUM: A reflective structure within the choroid; cellular in carnivores and fibrous in ungulates.

TARSUS: The margin of the eyelid; portion containing glandular structures and hair follicles.

TARSORRHAPHY: Temporary or permanent, an operation to decrease the size of the palpebral fissure; may be complete or partial.

TENON'S CAPSULE: A connective tissue sheath encompassing the eyeball posterior to the limbus and incorporating the muscles of the orbit.

TONOGRAPHY: Continuous measurement of intraocular pressure to evaluate aqueous humor outflow potential.

TONOMETRY: Measurement of intraocular pressure (usually in mmHg).

TRANSILLUMINATION: Passing a light beam through a structure; usually reflective transillumination in ophthalmology.

TRICHIASIS: Eyelashes which turn against the cornea.

UVEA: The vascular tunic of the eye, composed of the iris, ciliary body, and choroid.

UVEITIS: Inflammation of the uveal tract.

VIBRISSAE: Tactile hairs growing about the eye, nose, and/or muzzle.

VISUAL FIELD: The area which can be seen without shifting the gaze; can apply to each eye separately or both eyes combined.

XEROPHTHALMIA: Keratinization of the cornea and conjunctiva due to lack of tears.

* Glossary modified from Ophthalmology lecture notes (Wilkie, et al)