Focus on the Lens:
Lens Aberrations and Lens Surgery

Nancy B. Cottrill, DVM, MS, DACVO
Dr. Cottrill practices at Massachusetts Veterinary Referral Hospital

The normal lens is almost invisible, yet it performs the important function of focusing images on the retina. When it becomes more visible, as occurs in cataract formation, that’s when the trouble begins.

Anatomy

Just like in school, we always start at the beginning with the anatomy. The three basic regions of the lens are the anterior, posterior, and equatorial regions. The entire lens is enclosed in a capsule that has elastic properties, helpful during accommodation when the shape of the lens changes. The anterior capsule has a thin layer of epithelium that generates new lens fibers throughout life. The posterior capsule is thin.

Nature is inventive and has found a way to join the lens fibers together without a very visible seam. The "seams" are the Y-sutures. The anterior Y-suture is an upright "Y", more or less (some lenses do not follow directions). The posterior "Y" is inverted, more or less. Normal Y-sutures can be seen at times. The Y-sutures can help you identify depth and location in the lens by using the Purkinje Principle (P.P.). The P.P. states that an opacity will move with the motion of the lens if it is anterior, and away from the motion of the lens if it is posterior.

So what holds the lens in place? The zonules of Zinn of course. The Zs of Z are the structures that fail when a lens luxates. These fibers are important for accommodation.

The lens is composed of 65% water and 35% protein, most of which is soluble. Insoluble proteins increase in cataract formation. A low mineral content helps keep the lens clear and the normal metabolism intact. Hypercalcemia, for example, can cause a cataract.

Nutrition

During embryonic life, the lens receives nutrition from a vascular system that emanates from the optic nerve. Remnants of this system can cause opacities in the ocular media. After birth, nutrition is supplied from the aqueous. Alterations in the aqueous, such as inflammation, affect the lens. Normal metabolism of glucose in the lens can be overwhelmed in a diabetic, shunting the excess glucose to the sorbitol pathway, leading to imbibition of fluid by the lens and a cataract. Interestingly, this pathway is not very active in cats, so they do not usually develop diabetic cataracts. In dogs, 60-70% of diabetics will develop cataracts regardless of their level of control.

Aging of the Lens

The lens continues to grow throughout life. To compensate for this growth without filling up the globe, the lens fibers become more densely packed, leading to nuclear sclerosis. The central part of the lens becomes grayish, but there is no true opacity. Nuclear sclerosis does not affect the patient’s vision or the view of the fundus, except in very advanced cases. The visible aging change begins at about age six in dogs, and is seen much later in
cats. These changes are similar to tree rings and can help to estimate age in patients.

**Nuclear Sclerosis vs. Cataract**
It can be confusing to discriminate between nuclear sclerosis (NS) and cataracts (C). Considering their characteristics can help in this determination. NS begins after age six, it looks bluish-white, is centrally located, and does not affect the view of the fundus by the observer, or the outward vision of the patient. Cataracts are opaque areas that appear white when light is directed into the eye. If a tapetal reflex is elicited, the reflected light will be blocked by the opacity, making it appear black.

**Pathology of the Lens**
The lens is isolated during embryonic life. Inflammation occurs if lens proteins are released due to trauma or leakage. Phacoclastic uveitis is an example of a traumatic lens protein release, often due to a cat claw laceration or other trauma. Phacolytic uveitis occurs in mature and hypermature cataracts as the proteins leak through the capsule.

**Subluxation and Luxation of the Lens**
Subluxated lenses are still partially in their normal position in the hyaloid fossa and still maintain some zonular attachments. Luxated lenses are no longer in the hyaloid fossa and can be anterior or posterior. Their position can shift at will since there are no attachments. Clinical signs of a lens luxation or subluxation include iridodonesis, or "trembling" of the iris; increased, decreased, or inconsistent depth of the anterior chamber; an aphakic crescent, or area without the lens present in the pupil; increased intraocular pressure (IOP); corneal edema from the lens touching the corneal endothelium or by causing glaucoma; uveitis; vitreous in the anterior chamber.

The plan of action for a lens luxation involves many different variables. If the patient has vision, potential for vision, and has little chance of glaucoma post-op, the lens is removed by intracapsular extraction and an anterior vitrectomy performed. A ciliary sulcus fixation lens may be sutured in to the eye if it is a good candidate.

If the eye is not visual, has no light perception, and/or has glaucoma, salvage surgery is recommended. Salvage surgery includes enucleation or evisceration with intrascleral prosthesis implantation. An intravitreal injection of gentamicin or visiidide is not recommended due to the inflammation and difficulty in controlling IOP when the lens is shifted.

**Congenital Defects**
Congenital defects are uncommon, but interesting when they occur. These can include aphakia, or lack of a lens; microphakia, often a component of "multiple ocular defects"; spherophakia, or a round lens instead of an oval-shaped lens; lenticonus, or an outward protrusion of the posterior polar portion of the lens, often associated with cataracts in young dogs; coloboma, or notching of the lens equator; and embryonic vascular remnants, persistent hyperplastic primary vitreous (PHPV) or persistent hyperplastic tunica vasculosa lentis (PHTVL).

**Cataracts**
A cataract is a focal or diffuse opacity in the lens. There are various classification schemes including stage of development, location within the lens, and age of onset.

The stage of development is the most useful for the general practitioner. The four stages are as follows: incipient, involving less than 20% of the lens; immature, a tapetal reflex is still visible; mature, the whole lens is involved and no tapetal reflex is present; and hypermature, capsule appears wrinkly, the oval shape is lost and the anterior-posterior diameter is decreased compared to normal, the lens material appears glittery or pearlescent.

The location of the cataract is often characteristic by breed, since cataracts are considered to be inherited unless proven otherwise. Plotting the location of opacities can help determine progression on subsequent examinations.

Age of cataract onset is another classification scheme, with the divisions of embryonal, congenital, juvenile (present at less than six years of age), and senile (occurs at more than six years of age).
Etiology of Cataracts
Causes of cataracts include heredity, heredity and heredity. Other causes include diabetes mellitus, hypo- or hypercalcemia, electricity, very old age, congenital defects (PHPV, PPMs), trauma, nutritional ("Esbilac" or KMR cataracts).

Complications of Cataracts
Cataracts can cause a number of problems besides vision loss. Cataracts often lead to lens-induced uveitis and can lead to glaucoma and retinal detachment. Young dogs and dogs with rapidly developing cataracts tend to have more profound uveitis.

Diabetic Cataracts
Sixty to seventy percent of diabetics will develop cataracts in spite of good control. Characteristic clefts typically form in the Y-sutures. These cataracts are often intumescent, or swollen, and yield a shallow anterior chamber that may have a narrowed iridocorneal angle due to the increased size of the lens pushing the iris forward. Diabetics are also prone to spontaneous lens capsule ruptures; these can cause inflammation and glaucoma.

Complications of Cataract Surgery
Posterior capsular opacification is the most common complication of surgery. These opacities are the ones that are treated with a laser to try to disrupt them. Lasers are not used in people to remove cataracts, only these "after cataracts". Glaucoma is one of the potential long term complications of cataract surgery. Boston terriers, cockapoos, Shih Tzus, and Cocker spaniels are the breeds most likely to develop glaucoma after cataract surgery.

"Medical Therapy" for Cataracts
A recent study was performed to assess the effectiveness of an N-acetyl carnosine formulation (Ocluvet®) on canine cataracts. The study by Dr. David Williams (Veterinary Ophthalmology 2006 9 (5): 311-316) found that the reduction in opacification in immature cataracts was only 4.5%. There was no significant decrease in opacification in mature or hypermature cataracts.

Case Selection for Cataract Surgery
The best patients for surgery are healthy, have otherwise healthy eyes (no glaucoma, KCS, intact retina with good function), are amenable to handling, and do not have more than mild dental disease. Dental infections and disease can cause or contribute to ocular infections and inflammation. The owners must be committed to investing time, money and energy into the follow-up care.

Selection Criteria for Cataract Surgery
The immature stage is the best stage at which to remove cataracts. There is less inflammation, a better visual result, and less chance of retinal detachment, secondary glaucoma, and capsular opacities. Mature and hypermature cataract removal can still be successful however.

Evaluating the Retina
An electroretinogram (ERG) is done before surgery to assess retinal function. An ERG can detect retinal degeneration, such as PRA, years before ophthalmoscopic changes are evident. An ocular ultrasound is performed to check for retinal detachments.

Method of Cataract Removal
Phacoemulsification is the technique of choice yielding better, longer lasting results than previous techniques. This method involves emulsification of the lens material using a probe that vibrates at ultrasonic speed to break up the cataract. The same probe irrigates and aspirates concurrently to remove the lens material. The extracapsular technique requires a larger incision, produces far inferior results, and is rarely performed now. Lasers are not used for removal of cataracts in animals or humans.

Intraocular Lens Implants (IOLs)
Synthetic lenses are routinely implanted at the same time as cataract surgery to restore good vision. These implants are specifically designed for the canine or feline eye.

Post-Operative Care
Post-op care is crucial to the success of the surgery. There are frequent post-op visits and medications. The patient must be kept relatively inactive.

Success Rate of Cataract Surgery
Success is defined as return of good vision and is 85-90% depending on the surgeon. Success also depends on case selection and owner compliance. 99% of patients see the same day as surgery. The long-term success rate (>5 years) is 83%.

Lens surgery can be very rewarding for the patient and the owner. The return of the pet's normal behavior and personality are a joy to observe!
Notes:

Details on upcoming seminars as part of our continuing education series for veterinarians can be found on our website at www.intownvet.com/intown/seminars.html

Upcoming Veterinarian CE Lecture:
September 25, 2007 at 7:00pm. Tonopen wetlab for interested parties begins at 6:30pm.
Nancy B. Cottrill, DVM, MS, DACVO will present a lecture titled: **Focus on the Lens: Lens Aberrations and Lens Surgery.** The lecture will open with a Tonopen wetlab at 6:30pm. Dr. Cottrill will demonstrate, answer your questions and provide tips on IOP measurement with the tonopen.

Physical therapy and rehabilitation is now available at Mass Vet 6 days per week.
Outpatient ultrasound for non-critical pets is currently available 4 days per week.
In November we anticipate offering 7-day per week surgery.

Please feel free to call anytime you have questions about our services, availability or appointment schedules. We always try to accommodate your clients' needs.

If you are interested in using our RDVM online interface for real time access to case histories, discharge instructions, exam findings, lab results and more, email or call us at referringvets@intownvet.com or (781) 305-2240. We will be happy to set you up with a password. Instructions are available on our referring vets page.

www.InTownMassVet.com
Referring Veterinarians,

We are pleased to announce that at Massachusetts Veterinary Referral Hospital (Mass Vet) in Woburn we are continuing to expand and add emergency capacity to meet the increasing needs of our valued referral veterinarians. In the fall our emergency department will consist of 13 emergency veterinarians and one board certified emergency critical care specialist. Our emergency department is available to your clients 24 hours a day, 365 days a year.

At Mass Vet, as with all of our InTown hospitals, we strive to exceed your expectations and those of your clients. In July we implemented new standards of care for our ICU increasing the number of veterinary technicians per shift, and reducing the number of patients per tech. This latest enhancement has enabled us to assign patients to technicians based on technician skill levels and case complexity. More eyes in the ICU has its own benefit, however, assigning technicians to individual patients also ensures greater consistency in care and increased levels of accountability.

With easy access from both I-93 and I-95, your emergency clients have access to 6 day per week MRI, 4 day per week CT, 7 day per week surgery, 6 day per week neurology, internal medicine and physical therapy, 5 day per week ophthalmology, in and outpatient ultrasound, and a host of associated diagnostic modalities and treatment options.

We are always pleased to discuss any questions you may have regarding developments, services and new doctors at Mass Vet. Please feel free to call if we can answer any questions.

Best Wishes,

Timothy H. Smith, DVM, DABVP
Regional Medical Director

Mass Vet is located at
20 Cabot Road
Woburn, MA 01801

T: (781) 932-5802
F: (781) 932-5837

www.InTownMassVet.com
Announcement

Board Certified Specialist Services at Massachusetts Veterinary Referral Hospital

Referring Veterinarians,

We are pleased to announce that at Massachusetts Veterinary Referral Hospital (Mass Vet) in Woburn we are continuing to expand both the number of board certified services we offer, and the number of specialists on staff. This increase is necessary as we continue to strive to exceed your expectations and those of your clients. It has always been a significant part of our mission to minimize the wait time for your clients to make an appointment to see a specialist. This aspect remains the guiding force behind all of our technological advances and staff expansions.

In recent and upcoming months this range of expansions has included/will include:

- Adding dermatology as a new service offering.
- Increasing our internal medicine department to four board certified internists, with two internists available for saturday appointments.
- Doubling the size of our surgery department to four surgeons. In November 2007, this will enable us to offer 7-day per week surgery.
- Offering ophthalmology services 5 days per week at Mass Vet.
- Increasing the number of emergency doctors and technicians in the ICU 24 hours a day, 365 days a year.

We hope this translates into more availability, more doctors, more technicians and an ever increasing dedication to meeting your needs and those of your clients.

We are always pleased to discuss any questions you may have regarding developments, services and new doctors at Mass Vet. Please feel free to call if we can answer any questions.

Best Wishes,

Timothy H. Smith, DVM, DABVP
Regional Medical Director