

ADVANCES IN CATARACT SURGERY IN SMALL ANIMALS

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The ocular crystalline lens is a transparent, avascular, and highly defined structure that refracts light to a point on the retina. The lens is formed by surface ectoderm. As the lens vesicle forms the lens is surrounded by the basement membrane of the ectoderm, the posterior basement membrane remains as the posterior lens capsule and does not increase with thickness with age. The anterior capsule is partially formed by the original basement membrane, and continues to be produced or laid down by an existing layer of epithelial cells in the anterior lens.

A cataract is an opacity of the lens or the lens capsule. Loss of transparency occurs with almost all disorders of the lens. Because of the high prevalence of heritable cataracts in dogs, it is one of the most common causes of vision loss and blindness in dogs.

Cataract surgery has made dramatic improvements in veterinary and human ophthalmology since the late 1970's. Phacoemulsification and aspiration machines, handpieces, and needles have changed dramatically in the last 12 to 14 years. Other improvements in cataract removal in dogs include Viscoelastic agents, ocular pharmacology, availability of anti-inflammatory drugs, surgeon skill and experience, and improvements in intraocular lenses (IOLs). In spite of improved pre- and post-operative medications, Viscoelastic agents, improved technology, and better IOLs, cataract surgery continues to be an elective procedure in dogs and horses; whose successful outcome depends on surgeon skill, surgeon experience, meticulous attention to detail, and appropriate patient selection. The cataract surgeon should continue to rely on a minimum of medication, delicate tissue handling, familiarity with phaco machines and handpieces, shortened surgical time, and smaller well-controlled incisions to improve the ultimate success of the procedure.

Methods to ensure that the patient is prepared appropriately for surgery to avoid unnecessary complications:

Pre-operative medications:

- Anti-inflammatory agents,
- Pre-operative and intra-operative mydriasis
- Appropriate surgical preparation
- Patient and surgeon positioning
- Operating microscope for appropriate magnification
- Use of viscoelastics
- Nondepolarizing neuromuscular blockade
- Corneal incision controlled with phaco-blade
- Small incision Injectable/foldable IOLs

Pre-operative complications:

- Rule out common ophthalmic complications: KCS, corneal disease, eyelid deformity, retinal degeneration, and retinal detachment.
- Lens induced uveitis (LIU), Posterior synechiae, Lens subluxation, Vitreous presentation into the anterior chamber, lens capsule rupture, and Diabetes mellitus

these disorders will influence the surgical outcome but no longer preclude the patient from having cataract removal

1. LIU is best treated by topical corticosteroids (1% prednisolone acetate) or topical ophthalmic non-steroidal medications
2. Posterior synechiae can be surgically broken and disrupted at phaco surgery
3. Lens subluxation-instability can be managed in many cases using a two-handed surgical technique with placement of a foldable IOL or sulcus fixation of a PMMA IOL
4. Vitreous in the anterior chamber (AC) can be tamponaded with viscoelastic or removed by vitrectomy
5. Diabetes mellitus induced cataracts have an overall surgical outcome as non-diabetics
 - a. spontaneous lens capsule rupture may necessitate immediate cataract removal
 - b. often requires long term postoperative topical anti-inflammatory therapy with non-steroidal medication
 - c. more likely to have cell deposits on the IOL

Cataract Patient Selection:

Complete medical history, physical examination to evaluate for systemic disease or conditions that may complicate anesthesia and neuromuscular blockade. (cardiovascular, renal, hepatic, endocrine diseases). Patient temperament is a consideration since administration of postoperative medication and exercise restriction are essential for success.

Complete ophthalmic history and examination (eyelid, corneal, tear film, and retinal diseases should be ruled out).

Signs of LIU: Low IOP, aqueous flare, poor dilation with 1% Tropicamide in 20 to 25 minutes, hypopyon, hyphema.

Considerations for removal of hypermature cataracts: wrinkles, plaques, and fibrosis of the anterior lens capsule may indicate the same lesions of the posterior lens capsule. Posterior capsule changes may require a planned continuous tear posterior capsulorrhexis (PCTPC) or capsulectomy. Anterior capsule wrinkles, fibrosis, and plaques may increase the difficulty of the capsulorrhexis; and may necessitate scissor or radiohyperthermy capsulorrhexis.

Ideally the fundus should be examined by indirect ophthalmoscopy prior to surgery, in many cases this is not possible due to presentation for surgery when cataracts are complete. The surgeon then must rely on ERG and ultrasound evaluation of the retina.

Pre-operative evaluation includes Schirmer tear test, slit lamp biomicroscopy, indirect ophthalmoscopy, tonometry (Tonopen XL or TonoVet), and may include electroretinography, retinal ultrasound, and gonioscopy.

Ultrasound techniques:

1. B-mode ultrasonography (10MHz)
2. High-resolution ultrasound (HRUS, 20MHz)
3. Ultrasound biomicroscopy (UBM, 50 to 100 MHz)

B-scan US is used to identify the following: Retinal detachment, vitreal degeneration, asteroid hyalosis, PHPV/PHTVL, presence of spontaneous lens capsule rupture, axial length of the lens and globe, and posterior lenticonus. The incidence of retinal detachment and vitreal degeneration increases with later stages of maturity of the cataract. HRUS and UBM can be used to evaluate the anterior segment, specifically the iridocorneal angle (ICA) and the angle opening distance (AOD). Some surgeons have suggested that changes in the ICA and AOD may predict the development of postoperative ocular hypertension and glaucoma.

An ERG is performed to evaluate retinal function and rule out PRA. Older dogs with mild retinal atrophy, LIU, diabetics with lower amplitudes are frequently acceptable candidates, and see well for several years.

Some surgeons choose to perform prophylactic transscleral retinopexy to prevent post-operative retinal detachments, in certain breeds (Bichon Frise, Shih Tzu). In one report the incidence of retinal detachment following phacoemulsification was 55% without diode laser retinopexy and reduced to 12% using retinopexy.

The decision to perform cataract surgery must be based on the expected vision improvement, the risk of substantial postoperative complications, and the client's expectations following surgery. Retrospective studies have documented a higher success rate when immature cataracts are removed versus mature or hypermature cataracts. Advancements in surgical techniques, availability of newer phacoemulsification technology, use of viscoelastics, capsulorrhexis skill, IOL implantation (foldable IOLs), predicted surgical results, and the usual progression of cataracts in dogs; have, rightly so, shifted the paradigm of cataract removal to early rather than later mature or hypermature cataracts.

A short discussion of unilateral surgery may be in order, in man unilateral surgery is the rule even when bilateral cataracts are present. Part of the reason for this is the lack of required general anesthesia, which is necessary in dogs. Also, unilateral surgery decreases the risk of subjecting both eyes to possible risk factors including, endophthalmitis or bacterial contamination due to contaminated tubing, needles, irrigation fluid, or viscoelastic agents. Unilateral surgery in the dog is less expensive and monocular vision is adequate for most canine patients. However, this leaves the un-operated eyes at risk for LIU, retinal detachment, lens luxation, and glaucoma. Bilateral cataract removal in dogs has the advantage of a higher percentage of regaining vision in one or both eyes, lower overall costs when compared to two unilateral surgeries, and one anesthetic episode.

Preoperative Complications: Lens-induced uveitis, spontaneous lens capsule rupture, elevated IOP, vitreous in the anterior chamber, lens subluxation, retinal degeneration (PRA), retinal detachment, vitreal degeneration, synechiae, KCS, corneal opacities, corneal endothelial decompensation, corneal opacities, posterior lenticonus, PPMs, persistent hyaloid artery, persistent hyperplastic primary vitreous/ persistent tunica vasculosa lentis (PHPV/PTVL).

Surgical Equipment:

1. Phacoemulsification machines (older machines are of questionable standards) Some ophthalmic surgeons have gone so far as to suggest that a back up phaco machine is available in the event of failure of the primary unit while the eye is "open".
2. Automated irrigation /aspiration capabilities
3. Ophthalmic operating microscope
4. Microsurgical instrumentation (capsulorrhexis, suture tying 8-0 to 9-0, corneal incision)
5. Table to position microsurgical instruments
6. Vitrectomy capabilities
7. Foldable IOL placement
8. Ophthalmic operating chair for the surgeon
9. Neuromuscular blockade (paralyzing agents)
10. Ventilation and anesthetic monitoring
11. Prophylactic transscleral retinopexy (diode laser)
12. Prophylactic cyclophotocoagulation

Preoperative Therapy:

Almost no two ophthalmic surgeons agree on the preoperative medications and therapeutic regimes, however, most surgeons agree on the pre-operative therapeutic goals.

1. Broad-spectrum topical ophthalmic antibiotics every 6 hours for 24 to 48 hours prior to surgery
2. Topical corticosteroids are used for 48 to 72 hours prior to surgery or up to 4 weeks if LIU is present, usually 1% prednisolone acetate ophthalmic suspension is used.

3. Topical non-steroidal diclovanac or nepafenac 0.1% (Nvanac, Alcon) every 30 minutes beginning 1 to 3 hours prior to surgery
4. Mydriasis is induced with topical 1% Tropicamide and/or 1% atropine one to two hours prior to surgery. More frequent use of atropine is not recommended since it can lead to post-mydriasis miosis or intraoperative miosis.
5. Bolus of IV antibiotics at induction of anesthesia (IV Cephazolin)
6. IV flunixin meglumine 0.5 to 1.0 mg/Kg at induction of anesthesia some surgeons use SC carprofen at 2.2 mg/kg at induction)
7. Some surgeons use intracameral epinephrine (1:10,000) 0.1 to 0.5 ml during surgery to maintain mydriasis. Epinephrine facilitates mydriasis, decreases postoperative uveitis (flare, fibrin), causes vasoconstriction which controls potential hemorrhage. Some surgeons add epinephrine and heparin to the irrigating fluid, especially if LRS is used instead of BSS-Plus or BSS.

Surgical Positioning and Technique:

1. The patient is positioned beneath the operating microscope with the eyelids parallel to the floor. Most cataract patients are positioned using a vacuum bag or pillow.
2. Surgeon chair positioned a comfortable level and place for the surgeon
3. Operating microscope is positioned for the surgeon and assistant surgeon if needed
4. The eye and periocular area is prepared for aseptic surgery
5. An eyelid speculum is positioned
6. A single 6-0 silk stay suture is placed in the inferior nasal or temporal limbus incorporating bulbar conjunctiva and Tenon's capsule
7. Atracurium (paralyzing agent) is administered at this time
8. At this point I inspect the eye, cornea, and conjunctiva for foreign material and clean the incision site on the cornea with a cellulose spear
9. A limbal groove is made in the cornea for the corneal incision near the limbus (this incision facilitates wound healing)
10. A phaco blade of 2.8 to 3.4 mm is used to enter the anterior chamber forming a two-plane incision .
11. Right handed surgeons usually make the limbal incision slightly to the right of the 12-o'clock position.
12. If a blue dye to stain the anterior capsule is to be used a small air bubble is placed on the anterior lens capsule and the blue dye placed, it is allowed to stain the capsule for a few seconds and then the anterior chamber is filled with a Viscoelastic material.
13. The Viscoelastic is injected starting at the distal part of the AC and filling toward the corneal incision, expelling aqueous humor
14. Viscoelastic substances are indicated during all phacoemulsification and aspiration procedures. They maintain the AC, protect the corneal endothelium, facilitate capsulorrhexis or capsulotomy, dilate the pupil, fill the lens capsule for IOL implantation, tamponade vitreous if needed. Hylartin V, an equine intrarticular formulation of sodium hyaluronate is commonly used in the canine eye. However, it should be remembered that this product is not approved or labeled for intraocular use.
15. Viscoelastics are used in ophthalmic surgery to protect cells from mechanical trauma, create or preserve spaces for surgical manipulation, separate tissue, lubricate tissues, prevent adhesions, tamponade vitreous or hemorrhage.
16. Anterior capsulorrhexis
17. Hydrodissection if desired
18. Phacoemulsification: The phacoemulsification handpiece is designed to convert electrical energy into mechanical energy, and to emulsify the cataract (lens). The frequency of the handpiece varies from 27,000 to 60,000 cycles per second (kHz).
19. Irrigation and aspiration to remove peripheral or equatorial lenticular cortex use curved tip and "J" tip if desired.
20. Rinse IOL in sterile BSS or LRS, or saline
21. Load foldable IOL in the injector cartridge

22. Expand capsular bag with Viscoelastic may use a more viscous or higher molecular weight Viscoelastic
23. Enlarge limbal/corneal incision with "implant" blade for foldable IOL 3.8 to 4.8 mm
24. Insert IOL (usually a foldable acrylic IOL) and position IOL, check position
25. Remove remaining Viscoelastic material with automated I/A tip
24. Close corneal incision using 7-0 to 10-0 suture material.
25. Reform the AC with BSS or BSS Plus solution

Intraoperative Complications:

1. Anterior capsule fibrosis make the CTCC more difficult
2. Intraoperative miosis
3. Expanding vitreous syndrome: occurs most commonly in brachycephalic breeds, possibly in the Boston Terrier. May occur with either intact or a torn or ruptured posterior lens capsule.
4. Iris prolapse
5. Intraoperative hemorrhage
6. Lens capsule: A. Anterior radial tears. B. CTCC too small. C. Posterior capsule tears. D. Polishing opacities. E. Zonular tears or dehiscence
7. Vitreous presentation
8. Cavitation bubbles
9. Displaced or dislocated lens fragments
10. Phaco machine failure

Postoperative Complications: Immediate versus Long term

Immediate

1. Corneal ulceration
2. Wound dehiscence within 3 days post surgery
3. Surgery-induced corneal astigmatism
4. Endothelial decompensation (corneal edema)
5. Ocular hypertension (POH) (postoperative pressure spike) IOP greater than 25mmHg within 72 hours after phaco surgery.
6. Uveitis
7. Fibrin in the AC
8. Hyphema and/or vitreal hemorrhage
9. Acute endophthalmitis. This is uncommon, but hypopyon may develop in the first 48 hours post surgery. It may be caused by improperly sterilized instruments, or equipment, IOLs, unsterile irrigating fluids, unsterile or toxic materials, irrigating tubing, IOLs, viscoelastics. Some surgeons routinely perform cytology and or culture and sensitivity of the aqueous at the time the eye is entered for cataract removal. PCR testing can also be performed for bacterial and/or fungal DNA.
10. Toxic anterior segment syndrome (TASS). A few years ago there was a recall of BSS due to elevated levels of endotoxin. Affected eyes were addressed surgically as soon as hypopyon was noted. Antibiotics added to irrigating solutions is used to copiously irrigate the anterior chamber (AC). If a contaminated IOL is suspected an IOL from a different lot number or a different manufacturer should be used to replace the suspicious IOL. Or a PMMA IOL should be used to replace an acrylic.

Long-Term Complications

1. Posterior capsular opacities (PCO)
2. IOL decentration
3. IOL luxation out of the bag
4. Glaucoma
5. Retinal detachment
6. Corneal edema/Endothelial decompensation (especially Boston Terriers, Dachshunds, Chihuahuas-endothelial dystrophy)

7. Endophthalmitis -rare
8. Corneal stromal abscess -rare
9. Epithelial inclusion cysts -rare

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