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Cataract in dogs: A comprehensive review

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Abstract
Cataracts are a leading cause of vision impairment in dogs, characterized by the opacity of the lens that can significantly affect a dog's quality of life. Advanced age is the main risk factor for developing cataracts. This comprehensive review explores the etiology, classification, and current treatment options, emphasizing surgical interventions such as phacoemulsification. The study concludes that Phacoemulsification is currently the preferred approach due to its smaller incision requirement compared to intracapsular cataract extraction (ICCE) or extracapsular cataract extraction (ECCE), leading to reduced overall surgical time. It evaluates the prognosis for dogs that undergo cataract surgery and potential complications that may occur.

Keywords: Cataract, dog, advanced

Introduction
A cataract refers to cloudiness in the lens or its capsule, resulting from the death and disruption of the lens epithelial cells. Typically, cataracts progress to affect larger portions of the lens, and predicting the speed and extent of this progression can be challenging (Patil, 2014) [30]. This article emphasizes the significance of various cataract treatment methods for dogs and focusing on phacoemulsification collective with intraocular lens implantation and comparing it to other methods.

History
In the early days of cataract surgery in veterinary medicine, the ICCE (intracapsular cataract extraction) method was commonly used, involving mechanical or enzymatic zonulolysis with chymotrypsin (Startup, 1967; Barrie *et al*., 1982) [36, 2]. This method's advantage was the complete removal of the lens along with its capsule, preventing any lens material from remaining in the eye. However, it had drawbacks such as anterior displacement of the vitreous, which increased the risk of retinal detachment (Dziezyc, 1990) [8]. The subsequent method that was widely used for a long time was ECCE (extracapsular cataract extraction) (Startup, 1967; Rooks *et al*., 1985; Paulsen *et al*., 1986) [36, 34, 32]. The main disadvantages of ECCE included the large incision required and the necessity to perform surgery only when the cataract had matured. Currently, the preferred method in most cases is phacoemulsification. This technique involves removing the lens material through a small incision using fragmentation, emulsification, and aspiration (Miller *et al*., 1987; Gaiddon *et al*., 1988; Dziezyc, 1990; Nasisse *et al*., 1990; Davidson *et al*. 1991; Nelms *et al*., 1994; Gilger, 1997) [26, 14, 8, 28, 7, 29, 17].

Staging of cataract
Patients with cataracts exhibit varying degrees of lens opacity. A small localized opacity is termed an incipient cataract, where animals show no visual impairment (Stage 1). As opacity spreads to involve a larger portion of the lens, it becomes an immature cataract. A tapetal reflex may still be visible through parts of an immature cataract (Stage 2). When the entire lens is opaque, it is classified as a mature cataract, resulting in blindness as no tapetal reflex can be observed (Stage 3). Immature and mature cataracts can progress to hypermaturity, where the cataract begins to resorb.

Liquefied lens protein escapes through the lens capsule, causing the lens cortex and nucleus to shrink and the anterior lens capsule to wrinkle. As the diameter decreases, zonules may stretch and break, allowing vitreous to enter the anterior chamber (Stage 4). Hypermature cataracts are often associated with lens-induced uveitis (Fischer, C.A. 1983) [10].

Etiology of Cataract

Cataracts can develop due to a range of factors such as genetic predisposition, ocular disorders, injuries, toxic substances, aging, exposure to radiation, or electrical accidents (Davidson and Nelms, 2007) [6]. They are a leading cause of blindness in dogs, often leading to bilateral blindness in dogs (Gelatt and Mackay, 2005; Miller and Brines, 2018) [16, 25]. While hereditary cataracts are common in dogs, they may also result from other factors such as diabetes mellitus, chemical exposure, or trauma. Most cataracts observed in dogs are hereditary in nature. They typically affect both eyes but are seldom identical in appearance. Although pets may be brought in due to a cataract in one eye, a thorough examination post-dilation often reveals a cataract in the other eye as well. Other factors contributing to cataract formation include diabetes mellitus, feeding puppies milk replacer (Martin and Chambreau, 1982) [22], exposure to chemicals, radiation, electricity, and trauma. Cataracts can also develop as a result of conditions like uveitis and progressive retinal atrophy, which generally cannot be treated with surgery.

Preoperative Medications

Pre-surgery medications include two types: drugs for pupil dilation and those for anti-inflammatory purposes. Pupil dilation aids in accessing the lens during surgery and helps decrease the possibility of synechia post-surgery. Both parasympatholytics like atropine and sympathomimetics such as phenylephrine are used for this purpose. Anti-inflammatory medications are given to counteract the considerable uveitis caused by surgical manipulation of the eye. These medications include both topical like prednisolone or dexamethasone, as well as systemic corticosteroids such as prednisone. Additionally, nonsteroidal anti-inflammatory drugs, both topical like flurbiprofen and systemic like flunixin meglumine, are employed for this purpose.

Anesthesia

In veterinary medicine, general anaesthesia is undoubtedly essential. Previously, ophthalmic text recommended methoxyflurane for cases involving a soft, centrally located globe (Magrane, 1971) [23]. However, most ophthalmologists and anaesthesiologists now prefer other inhalant anaesthetics such as halothane or isoflurane, particularly for elderly patients. Surgeons generally favor systemic neuromuscular blocking agents because they simplify procedures by preventing bulbar rotation (Dziezyc, 1990; Nasisse and Davidson, 1991) [8, 27]. Muscle relaxants like pancuronium or atracurium have significantly improved cataract surgery. These agents ensure the eye remains centrally positioned with no movement during the procedure, eliminating the need for deep anaesthesia. Moreover, by paralyzing the extraocular muscles, they reduce the likelihood of vitreous prolapse.

Treatment of Cataract

Treatment for canine cataracts may involve the use of eye drops to delay progression or surgical intervention to replace the affected lens with an artificial intraocular lens (IOL) (Dziezyc, 1990) [8].

The choice of surgical method depends on factors like the dog's age, symptoms, and anticipated postoperative care. Surgery is typically recommended when cataracts cause vision impairment or when progressive vision loss is expected (Raghuvanshi and Maiti, 2013) [33]. However, a thorough assessment of the lens is crucial before surgery to ensure optimal postoperative outcomes (McCalla, 2005) [24].

Surgical Treatment

There are surgical techniques used to remove a cataract: (1) intracapsular extraction, (2) extracapsular extraction, (3) Phacoemulsification

Intracapsular Cataract Extraction

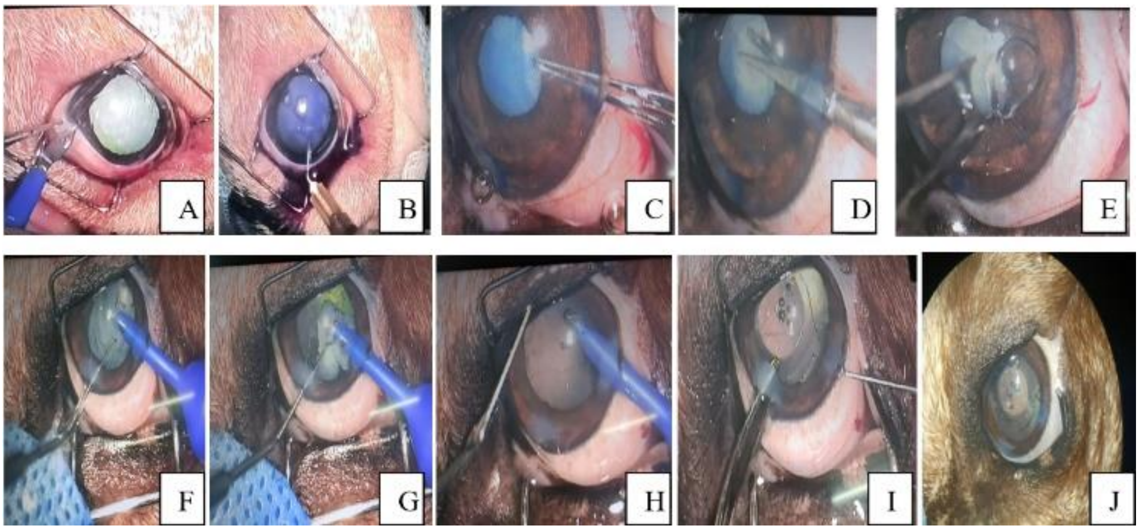
Intracapsular cataract extraction involves removing the entire lens cortex and nucleus enclosed within the intact lens capsule through a large incision near the limbus. This method was once widely used for cataract removal in humans before intraocular lenses (IOLs) became common. However, its use in dogs is now primarily restricted to cases involving luxated lenses. For non-luxated lenses, the zonules must be disrupted before the intact lens can be extracted, and there is often persistent attachment of the vitreous to the posterior lens capsule (hyaloideocapsular ligament), leading to anterior vitreous prolapse during extraction. This complication is associated with postoperative issues such as retinal detachments, wound opening, and choroidal hemorrhage.

Extracapsular Cataract Extraction

Extracapsular cataract extraction is likely the most frequently performed procedure in dogs. It involves making an incision at or near the limbus, removing the anterior capsule, and extracting the entire cortex and nucleus. Challenges with this method include the necessity for a large incision to accommodate the large lenses of dogs and cats, which can cause eye collapse and significant uveitis. The large incision also increases the risk of wound opening and can result in prominent scars. Eye collapse during surgery often causes pupil constriction, making it difficult to remove the nucleus and challenging to visualize and remove residual cortex adhered to the posterior and equatorial lens capsule, particularly near the lens equator. These remnants of lens material left behind contribute to postoperative uveitis.

Phacoemulsification

Phacoemulsification represents an advanced technique for cataract removal, employing ultrasonic fragmentation and suction through a small corneal incision. This method allows for precise removal of the cataract while minimizing damage to the posterior lens capsule. When an intraocular lens (IOL) is implanted, adjustments are made to the diameter of the anterior capsulectomy accordingly (Tripathi *et al*., 2024) [37].



Source: Tripathi *et al*. (2024). Successful management of cataracts in dogs by phacoemulsification with IOL implantation: Review of two case. International Journal of Veterinary Sciences and Animal Husbandry, 9(2): 100-103.

Fig 3: Showing Cataract surgical procedures steps by Phacoemulsification (A) Corneal tunnel, (B) Instillation of trypan blue dye, (C,D) Continuous Curvilinear Capsulorrhexis, (E) Hydrodissection, (F, G) Phacoemulsification of cataract, (H) Aspiration of cortical lens matter, (I) IOL implantation, (J) After IOL placement

Over recent decades, advancements in microsurgical techniques, particularly phacoemulsification and intraocular lens (IOL) implantation, have significantly enhanced the success rates of cataract surgery (Boldy, 1988; Dziezyc, 1990) [4, 8]. Phacoemulsification is widely accepted as the standard method for cataract removal in veterinary ophthalmology. The implantation of intraocular lenses is crucial for achieving optimal visual outcomes in both humans and dogs (Lim *et al*., 2011; Sigle and Nasisse, 2006) [21, 35].

Intraocular Lens Implantation in Dogs

There are two primary types of intraocular lenses used in veterinary practice: hard lenses (PMMA - Gilger *et al*., 1993) [18] and foldable lenses made of silicon (Gilger *et al*., 1993; Gaiddon *et al*., 1997) [18, 12] or acrylic polymers (Rosolen, personal communication, 2004). These lenses are implanted within the capsular bag; the use of lenses supported by the anterior chamber or iris is avoided due to high complication rates (Nasisse and Davidson, 1991) [27]. The most common optic power is 41D (Gaiddon *et al*., 1991) [13], with haptic sizes ranging from 14 to 18 mm and a 7 mm optic diameter. While PMMA lenses have been traditionally used, there is a growing trend towards using soft, foldable lenses, with the latest types made from hydrophilic acrylate. Acrylic lenses offer advantages such as smaller incisions and excellent biocompatibility. Foldable materials may facilitate quicker postoperative recovery with minimal intraoperative damage to ocular tissues.

Postoperative medications

After surgery, animals are closely monitored and treated with a regimen that includes topical antibiotics (0.5% Moxifloxacin HCL), artificial tears (0.5% Carboxymethyl Cellulose), and anti-inflammatory eye drops (0.1% Fluorometholone), administered 3 to 4 times daily. Additionally, broad-spectrum systemic antibiotics and anti-inflammatory drugs are given twice daily for 7 days. Owners are advised to keep an Elizabethan collar on the animal for 2 to 3 weeks post-surgery to prevent self-injury (Tripathi *et al*., 2024) [37].

Postoperative complications

According to Fischer and Meyer-Lindenberg (2018) [11], complications were observed in 43.5% of cases, occurring at various stages of cataract development, with higher frequencies noted as cataracts became more advanced.

Uveitis

Uveitis represents a significant challenge following veterinary cataract surgery. Within hours of the procedure, flare and fibrin can be observed in the anterior chamber. Severe cases of uveitis may cause miosis despite the use of mydriatics before and after surgery. Preoperative lens-induced uveitis, while not a contraindication, can lower success rates, particularly with extracapsular procedures. In one study, success rates were 95% at 6 months for dogs without lens-induced uveitis, compared to only 52% in those with such uveitis (Paulsen *et al*., 1985) [31].

Glaucoma

Glaucoma is frequently seen following phacofragmentation procedures. It typically manifests within hours of surgery and often resolves within 24 hours. Factors contributing to transient glaucoma may include the use of antiprostaglandins, temporary angle swelling, and obstruction of the drainage angle by small lens fragments. In some cases, glaucoma may persist, leading to surgical failure. Possible causes include peripheral anterior synechiae, iris bombe, and "malignant glaucoma," where aqueous humor is trapped in the vitreous, pushing the iris and vitreous forward, especially in dogs with previously undiagnosed primary glaucoma.

Capsular Opacities

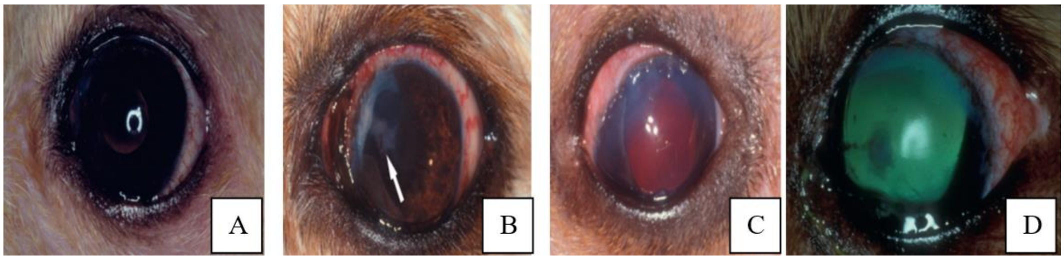
Posterior capsular opacification (PCO) is the most common complication following modern cataract surgery. Both anterior and posterior capsular opacities can potentially impair vision. These opacities develop postoperatively due to fibrous tissue deposition by iris root or ciliary body cells, affecting either capsule. PCO formation is inevitable in all dogs undergoing phacoemulsification and IOL implantation. Factors such as young age, small to medium breeds, and early stage cataracts at surgery may influence PCO development. Over time, PCO incidence increases in diabetic and non-diabetic dogs, while inflammatory episodes do not significantly affect PCO formation (Bras *et al*., 2006) [5].

Corneal Endothelial Damage

Corneal endothelial damage is a concern with any intraocular procedure. Since the endothelium in adult dogs and cats does not regenerate, the destruction of a significant number of endothelial cells can lead to corneal edema. Extracapsular procedures tend to cause more damage to corneal endothelial cells than phacofragmentation in dogs (Gwin *et al*., 1983) [20]. Air is toxic to the endothelium, and air bubbles in the phacofragmentor lines that enter the anterior chamber can cause endothelial damage (Beesley *et al*., 1986). Recently, viscoelastic materials have been utilized to protect the corneal endothelium during surgery and maintain the anterior chamber. Substances such as sodium hyaluronate, hydroxypropyl methylcellulose, sodium chondroitin sulfate-sodium hyaluronate, sodium chondroitin sulfate-hydroxypropyl methylcellulose, collagen, and polyacrylamide are used for this purpose (Alpar, 1987) [1]. Early studies in dogs suggest that viscoelastic materials can decrease the incidence of posterior synechiae and inflammation in both intracapsular and extracapsular lens extraction procedures.

Retinal Detachment

Retinal detachment is a rare but severe postoperative complication that can result in blindness. Rhegmatogenous detachments, which involve retinal tears, have been observed in dogs following cataract surgery (Dziezyc *et al*., 1986) [9].



Source: Veterinary Ophthalmic Surgery by Kirk N. Gelatt, Janice P. Gelatt

Fig 2: (A) The immediate iridocyclitis after phacoemulsification appears (B) Postoperative aphakic glaucoma in a dog 4 weeks after extracapsular cataract extraction. The miotic pupil (arrow) eventually became obstructed with the fibropupillary membrane (C) Hyphema and vitreal hemorrhage secondary to early retinal detachment following intracapsular lensectomy for lens luxation in a dog (D) Large but shallow corneal ulceration 2 days after cataract surgery. Cause was apparently a weak and inadequate blink reflex. Note the anterior chamber is very shallow.

Conclusions

Cataract surgery in dogs can be highly effective in restoring vision, leading to satisfying outcomes. However, the presence of concurrent ocular conditions such as keratoconjunctivitis sicca (KCS), uveitis, glaucoma, lens subluxation, and retinal disease can complicate the procedure or act as contraindications for lens removal. Various surgical methods for cataract removal are available, including intracapsular cataract extraction, extracapsular cataract extraction, and phacoemulsification. Among these, phacoemulsification is currently the most successful technique in dogs. This method is preferred due to its requirement for a smaller incision compared to intracapsular or extracapsular cataract extraction. Phacoemulsification not only reduces the overall surgical time but also improves visual function post-surgery and lowers the risk of developing posterior capsular opacity (PCO).

Conflict of Interest: There is no potential conflict of interest relevant to this article.

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