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Research Article

Postoperative Bilateral Phacoemulsification Outcomes in Dogs Receiving Subconjunctival Triamcinolone With or Without Topical Anti-Inflammatory Therapy ("Dropless" Cataract Surgery)

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Abstract

Purpose: To determine if postoperative topical anti-inflammatory therapy (pTAT) affects phacoemulsification outcomes in dogs receiving subconjunctival triamcinolone (ST).

Methods: Dogs undergoing bilateral phacoemulsification were identified retrospectively. Age, sex, breed, injectable and oral anti-inflammatory therapy, diabetic status, fibrin formation, follow up times, visual outcomes, glaucoma (IOP > 24mmHg) and need for pTAT rescue therapy if flare present postoperatively were compared between groups. Statistics were performed for all comparisons (p=0.05).

Results: 626 eyes were included. 525 eyes received pTAT (diclofenac or ketorolac BID and dexamethasone BID) and 101 eyes did not receive pTAT. All eyes received 4mg ST perioperatively. All dogs received postoperative oral carprofen (diabetics) or prednisone (non-diabetics). There was no significant difference in age, breed, sex, diabetic status, fibrin formation or follow up times between groups. In all eyes, the odds of glaucoma were 70% higher and the odds of vision were 78% lower with pTAT. In diabetics, the odds of glaucoma were 39% lower and the odds of vision were 70% higher than non-diabetics. In non-diabetic eyes, the odds of glaucoma were 240% higher and the odds of vision were 93% lower with pTAT. 40/101 (40%) of eyes needed rescue pTAT.

Conclusions: pTAT after phacoemulsification increased the risk of glaucoma and blindness in non-diabetic eyes, but did not affect these factors in diabetic eyes. ST without pTAT ("dropless" cataract surgery) is safe and may control post-phacoemulsification uveitis. Further work is needed to determine the effect of diabetic status on the risk of glaucoma and blindness. None.

INTRODUCTION

Cataracts, defined as opacification of the crystalline lens, are common in dogs and are most frequently caused by primary/genetic etiologies or secondary to diabetes mellitus. Other less frequent causes include age-related degeneration, trauma, nutritional deficiencies, toxin exposure, and intraocular inflammation. Phacoemulsification is the gold-standard treatment for cataracts in dogs causing vision loss or blindness. Adapted from human ophthalmology in the 1960s and implemented in veterinary ophthalmology since the 1980s, this technique yields long-term functional vision in approximately 80–90% of canine patients [1,2]. Surgical outcomes are influenced by ocular health status, surgeon expertise, cataract stage, and client compliance in postoperative management.

Cataract surgery causes intraocular inflammation (uveitis) [3], which can result in patient discomfort, intraocular hypertension, glaucoma, fibrin deposition, pre-iridal fibrovascular membrane formation, and other vision-threatening complications. Systemic and topical anti-inflammatory therapies are standard-of-care in both human and veterinary medicine to mitigate post-phacoemulsification uveitis [4-8]. Effective suppression of postoperative inflammation is widely regarded as essential for optimizing surgical outcomes; however, an

ideal route of anti-inflammatory administration has not yet been clearly established.

Glaucoma is the leading cause of vision and globe loss following canine cataract surgery [9,10]. Although topical anti-inflammatory medications reduce post-phacoemulsification uveitis, their use has been associated with an increased risk of glaucoma in dogs [11-13]. In contrast, systemic anti-inflammatory therapy has not been shown to affect intraocular pressure in dogs, but is generally considered insufficient as a sole modality for controlling postoperative uveitis after cataract surgery.

"Dropless" cataract surgery, recently described in human ophthalmology, eliminates the need for postoperative topical anti-inflammatory medications by delivering long-acting triamcinolone via subconjunctival or transzonular injection [14-25]. This approach reduces dependence on patient compliance, lowers costs, minimizes environmental waste from topical medications, and decreases aftercare demands. Both subconjunctival and transzonular triamcinolone have been demonstrated to effectively prevent post-phacoemulsification uveitis, with efficacy comparable to that of conventional topical therapy [17-25].

One recent study found no difference in transzonular versus subconjunctival triamcinolone anti-inflammatory effects in dogs after phacoemulsification used concurrently with topical therapy [26]. To the author's knowledge, "dropless" cataract surgery has not been reported in the veterinary ophthalmology literature. This study therefore aimed to compare postoperative outcomes in a large cohort of dogs receiving subconjunctival triamcinolone with or without adjunctive topical anti-inflammatory medication.

METHODS

Dogs undergoing bilateral phacoemulsification (cataract surgery) for cataracts causing visual impairment or blindness were identified retrospectively from 2018 to 2024. All dogs underwent surgery after informed client consent. Dogs were placed into two groups: 1) dogs receiving an immediate postoperative subconjunctival triamcinolone injection with postoperative topical anti-inflammatory therapy following phacoemulsification and 2) dogs receiving an immediate postoperative subconjunctival triamcinolone injection without postoperative topical anti-inflammatory therapy following phacoemulsification. Signalment including age, sex and breed were recorded for all dogs. Additionally, pre- and postoperative topical medications, perioperative injectable anti-inflammatory medications, postoperative oral anti-inflammatory medications, diabetic status, postoperative fibrin formation, follow up times, visual outcomes, postoperative glaucoma formation and need for postoperative topical anti-inflammatory therapy if flare was present after surgery were compared between groups. Within the two groups, outcomes were compared for diabetic versus non-diabetic dogs separately to determine the effect of diabetes on outcomes. Glaucoma was defined as an intraocular pressure measurement via applanation tonometry greater than 24mmHg obtained more than 24 hours after cataract surgery.

Statistical Analysis

All analyses were performed using SAS 9.4 (Cary, NC). A significance threshold of 0.05 was used. The assumption of normality for age was evaluated via inspection of QQ-plots, histograms, and skewness. Age was left skewed, so age was summarized descriptively with median, interquartile range and range. There were 2 groups compared, namely anti-inflammatory vs no anti-inflammatory and diabetic vs not diabetic. To explore the effect of presence of diabetes on difference due to anti-inflammatory use, differences were tested separately for diabetic and non-diabetic dogs. There was one dog in which the eyes were treated differently resulting in one eye in each group, therefore represented twice in the analysis of age, sex and breed. Age was compared between groups with a Mann-Whitney test. Sex was compared between groups with a Fisher's exact test. Generalized linear mixed models (logistic GLMMs) were used to analyze visual and glaucoma outcomes with a random intercept for each dog to account for clustering of eyes within dogs. The GLMM to compare between groups for each outcome included a fixed factor of group. Satterthwaite degrees of freedom method and Residual Pseudo-likelihood estimation were used. A Cox proportional hazards frailty model was used to test if visual and follow-up times were different between groups. The model had a fixed factor of group and a random factor of dog. Kaplan Meier curves for visual times for each group were constructed and used to estimate median visual times and follow-up times. For visual times eyes that still had vision at last follow-up were censored. For follow-up times eyes that were not followed up past the date they became not visual were censored. To consider the impact of diabetes on anti-inflammatory use, alternative GLMM and Cox proportional hazard models with fixed factors of anti-inflammatory use and diabetes and their interaction effect were utilized.

RESULTS

There were 626 eyes included in the study, representing 313 dogs. All eyes received 4mg of subconjunctival

triamcinolone in the dorsal bulbar conjunctiva administered through a sterile 25g needle immediately following phacoemulsification. There were 525 eyes (263 dogs) that received postoperative topical anti-inflammatory therapy and 101 eyes (51 dogs) that did not receive postoperative topical anti-inflammatory therapy following phacoemulsification. These numbers represent one dog that had one eye receiving postoperative topical anti-inflammatory therapy and one eye not receiving postoperative topical anti-inflammatory therapy. All other dogs received the same treatments for both eyes.

Signalment

There was no difference in age or sex between the two groups. Diabetic dogs were significantly older than non-diabetic dogs ($p<0.001$). There were 146 breeds represented. There were too few dogs per breed to analyze breed distributions statistically between groups.

Topical Medications

All eyes underwent pharmacologic mydriasis prior to cataract surgery. This was performed using one drop of tropicamide and one drop of atropine instilled 1-5 minutes apart every 10 minutes for three rounds. Thus, each eye received a total of 3 drops of atropine and 3 drops of tropicamide. At the completion of cataract surgery, all eyes received one drop of atropine, one drop of dorzolamide/timolol and a small strip of petroleum-based artificial tear ointment with no waiting period in between these medications since the patients were still under the effects of general anesthesia and were not actively blinking.

Phacoemulsification was completed routinely in all eyes. Postoperatively, eyes receiving topical anti-inflammatory therapy were prescribed dexamethasone and either diclofenac or ketorolac. The clients were instructed to instill 1 drop of each medication every 12 hours (twice daily) in both eyes. Topical anti-inflammatory therapy was not implemented in the hospital after surgery. Patients were discharged 1-4 hours after anesthetic recovery. Both medications were instructed to be continued indefinitely during the follow up period. The topical anti-inflammatory medications were continued for at least four months in eyes receiving topical therapy. At or around four months, dexamethasone was discontinued and diclofenac or ketorolac was instructed to be continued indefinitely twice daily.

Diabetic eyes, eyes diagnosed with keratoconjunctivitis sicca prior to cataract surgery or eyes in dogs over 10 years of age were prescribed topical tacrolimus or cyclosporine once or twice daily before phacoemulsification. These medications were continued indefinitely after phacoemulsification or were discontinued at the discretion of the managing clinician during the postoperative follow up period.

Injectable and Oral Anti-Inflammatory Medications

All dogs received intravenous (IV) 0.5mg/kg dexamethasone SP and IV 1.0mg/kg flunixin immediately prior to cataract surgery concurrent with surgical rate IV fluid therapy given for the duration of anesthesia.

All non-diabetic dogs were prescribed oral 0.5-1.0mg/kg prednisone once daily for 4 days, then every other day for 10 days after phacoemulsification. All diabetic dogs were prescribed oral 2.2mg/kg carprofen twice daily for 14 days after phacoemulsification.

Postoperative Fibrin Formation

In eyes receiving postoperative topical anti-inflammatory therapy, 17/525 (3%) developed intraocular fibrin. In eyes not receiving postoperative topical anti-inflammatory therapy, 3/101 (3%) developed intraocular fibrin. All eyes that developed fibrin were affected within one month after cataract surgery. A single injection of 37.5µg tissue plasminogen activator was administered intracamerally to treat fibrin and all eyes had resolution of fibrin at the following evaluation. There was no difference in fibrin formation between groups.

Follow Up Times

The median follow up time for eyes not receiving postoperative topical anti-inflammatory therapy was 15 months. The median follow up time for eyes receiving postoperative topical anti-inflammatory therapy was 14 months. There was no difference in follow up times between groups.

Diabetic Status

Postoperative topical anti-inflammatory therapy was utilized in 84% of total diabetic eyes and 84% of total non-diabetic eyes, thus any effects of being diabetic would balance out between groups. Additional information regarding diabetic status and impact on visual outcomes and glaucoma is included in those sections respectively.

Visual Outcomes

During the follow-up period, blindness occurred in 102/525 (19%) eyes treated with topical anti-inflammatory therapy compared with 5/101 (5%) eyes not receiving topical therapy, representing a statistically significant increase in blindness associated with topical

anti-inflammatory use (p = 0.003). The odds of being visual were 78% lower in eyes receiving topical anti-inflammatory group compared to eyes not receiving topical therapy.

Blindness occurred in 56/260 (22%) non-diabetic eyes versus 51/366 (14%) diabetic eyes, indicating a significantly higher risk of blindness in non-diabetic eyes (p=0.033). In non-diabetic eyes not receiving topical therapy, 1/42 (2%) became blind which was significantly lower than 55/218 (25%) non-diabetic eyes receiving topical therapy that became blind. The odds of being visual were 93% lower in non-diabetic eyes receiving topical anti-inflammatory therapy than non-diabetic eyes not receiving topical therapy. There was no significant difference in the incidence of blindness in diabetic eyes not receiving topical therapy [4/59 (7%)] versus diabetic eyes receiving topical therapy [47/307 (15%)] (p=0.126).

Postoperative Glaucoma

During the follow up period, glaucoma occurred in 127/525 (24%) eyes treated with topical anti-inflammatory therapy compared with 16/101 (16%) eyes not receiving topical therapy. This difference was not significant (p=0.118).

Glaucoma occurred in 72/260 (28%) non-diabetic eyes versus 71/366 (19%) diabetic eyes, indicating a significantly higher risk of glaucoma in non-diabetic eyes (p=0.047). In non-diabetic eyes not receiving topical therapy, 5/42 (12%) developed glaucoma which was significantly lower than 67/218 (31%) non-diabetic eyes receiving topical therapy that developed glaucoma (p=0.038). The odds of glaucoma were 240% higher in non-diabetic eyes receiving topical anti-inflammatory therapy than non-diabetic eyes not receiving topical therapy. There was no significant difference in the incidence of glaucoma in diabetic eyes not receiving topical therapy [11/59 (19%)] versus diabetic eyes receiving topical therapy [60/307 (20%)] (p=0.856).

Topical Anti-Inflammatory Rescue Therapy

Flare was present in 40/101 (40%) of eyes not receiving postoperative topical anti-inflammatory therapy following phacoemulsification. Flare was present in 23/59 (39%) diabetic eyes and in 17/42 (40%) non-diabetic eyes. There was no difference in diabetic status and whether flare was present after phacoemulsification. All eyes not receiving topical anti-inflammatory therapy with flare at any time point after cataract surgery were treated with rescue topical anti-inflammatory therapy using diclofenac or ketorolac and/or dexamethasone at the managing clinician's discretion. A single topical anti-inflammatory medication was used in 30/40 (75%) of eyes while two topical anti-inflammatory medications were used in 10/40 (25%) of eyes. Topical anti-inflammatory therapy was continued until no flare was present, at which time, it was discontinued. All eyes that developed flare were affected within one month after cataract surgery. The mean time of treatment was 2.5 months for all eyes with flare after phacoemulsification.

DISCUSSION

This report evaluates postoperative phacoemulsification outcomes in canine eyes treated with subconjunctival triamcinolone, with or without adjunctive topical anti-inflammatory therapy, a protocol referred to as "dropless" cataract surgery. However, in human ophthalmology, "dropless" denotes the complete absence of postoperative topical medication. In the context of our study, many of our patients were receiving ocular surface stabilizing medication once or twice daily prior to cataract surgery. These medications were continued after surgery. Diabetic dogs, unlike diabetic humans, have a high prevalence of secondary cataracts due to species differences [27]. Diabetes is a known cause of canine corneal disease [28]. Consequently, in this study, "dropless" surgery does not indicate the absence of all topical therapy, but specifically the omission of topical anti-inflammatory drugs. Despite many dogs receiving one topical medication once or twice daily in our study, the overall workload for clients was dramatically reduced by eliminating topical anti-inflammatory therapy after phacoemulsification. Of note, one drop of dorzolamide/timolol was instilled at the completion of cataract surgery based on decreased post-operative ocular hypertension associated with its use [29]. No other topical therapy was utilized unless glaucoma, uveitis or corneal ulceration developed in the postoperative period.

A standardized postoperative topical anti-inflammatory phacoemulsification protocol does not exist in the veterinary literature; thus, wide variation exists in veterinary ophthalmology regarding the number of topical medications and the frequency of administration. In our study, topical anti-inflammatory therapy with a steroid and nonsteroid medication instilled twice daily increased the incidence of glaucoma and vision loss in non-diabetics and did not affect the incidence of glaucoma and vision loss in diabetics. This may suggest that topical therapy would either be unnecessary or may be deleterious when given with subconjunctival triamcinolone. Increasing the frequency of topical anti-inflammatory therapy from twice daily may also be of no benefit if subconjunctival

triamcinolone is used, although further work is needed to clarify whether the frequency and number of topical anti-inflammatory medications affect clinical outcomes after canine cataract surgery.

Triamcinolone is routinely used in human ophthalmology after phacoemulsification, administered via either subconjunctival or transzonular routes. Human studies show similar efficacy for both routes with no route of administration being identified as superior to the other [14-25]. In this study, we chose to administer triamcinolone via the subconjunctival route due to ease of administration and lower risk of endothelial cell loss as transzonular triamcinolone has been linked to a higher incidence of corneal endothelial cell damage [30]. Additionally, if negative side effects were encountered or suspected as a direct result of the triamcinolone, the conjunctival region was readily accessible for removal of the remaining drug residue. This was not necessary in this study but speaks to the rationale behind the choice. Intracameral triamcinolone has been shown to reduce postoperative inflammation for up to 10 days following phacoemulsification in dogs; [31] however, this route of administration is expected to have a relatively short duration of effect. Because subconjunctival triamcinolone provides a longer duration of action, it was selected for this study. In this study, triamcinolone appeared to be safe as no direct negative side effects were noted.

Rescue topical anti-inflammatory therapy was utilized for 40/101 (40%) of eyes that did not initially receive postoperative topical anti-inflammatory treatment following phacoemulsification. Because the use of subconjunctival triamcinolone without adjunctive topical therapy was a novel approach, topical treatment was initiated promptly at any sign of postoperative flare, including mild (≤1+) flare without associated clinical symptoms, as a precautionary measure. Of note, the presence of flare was not documented in eyes receiving topical therapy even though some of the eyes likely had flare at some point during the post-operative period. These cases likely resolved with continued topical treatment. Based on subsequent clinical experience with subconjunctival triamcinolone used in this way, the authors now observe asymptomatic eyes with ≤1+ flare and do not implement immediate topical intervention. Most of these cases resolve spontaneously over time. Consequently, the reported rate of rescue therapy likely overestimates the true need for topical anti-inflammatory treatment, as mild or subclinical postoperative uveitis may resolve spontaneously without additional therapy.

Topical anti-inflammatory therapy may adversely affect corneal integrity by potentiating corneal breakdown, malacia, and infection, although it has not been directly shown to cause corneal ulceration [32]. It was beyond the scope of this study to formally evaluate postoperative corneal disease after cataract surgery due to its multifactorial nature. Within one month after cataract surgery, corneal ulceration occurred in 20/626 (3%) eyes. Notably, 18 of 20 eyes with ulceration received topical anti-inflammatory therapy. A potential additive ("doubling-down") effect of injectable triamcinolone and topical anti-inflammatory therapy is possible, but the incidence of corneal ulceration was so low that this remains very speculative. Further studies are needed to clarify the role of topical and injectable anti-inflammatory therapies in postoperative corneal ulceration following phacoemulsification.

Unexpectedly, this study found a lower incidence of postoperative glaucoma and vision loss in diabetic dogs compared with non-diabetic dogs following cataract surgery, independent of topical anti-inflammatory treatment. One previous study showed no differences in phacoemulsification outcomes in diabetic versus non-diabetic dogs [33]. The difference in this study may be attributed to postoperative systemic steroid use in non-diabetic dogs, which was not used for diabetic dogs. Oral steroid therapy has been shown to increase the risk of intraocular hypertension in humans [34], and may also impact dogs, although no studies to date suggest this. It is also possible that unidentified differences in ocular physiology exist between diabetic and non-diabetic dogs. Notably, diabetic dogs were significantly older than non-diabetic dogs which is paradoxical regarding the glaucoma incidence since age-related stiffening of the iridocorneal angle typically increases glaucoma risk [35]. An alternative explanation is earlier surgical intervention in diabetic dogs improves surgical outcomes, as rapid cataract progression often prompts clients to pursue surgery at an earlier disease stage since their dog's vision is impacted quickly once cataracts develop. Overall, these findings highlight gaps in our understanding of factors influencing postoperative phacoemulsification outcomes in dogs.

This retrospective study of client-owned dogs has several limitations. The incidence of postoperative glaucoma may be underestimated because intraocular pressure was measured at variable postoperative time points due to the nature of a clinical based study and client scheduling availability; however, any unrecorded pressure elevations appeared to be transient, as subsequent measurements were normal. Gonioscopy was not routinely performed during the study period, limiting the ability

to identify dogs at risk for glaucoma. The authors now include gonioscopy preoperatively based on recent data supporting this assessment's prognostic use [36]. Despite this limitation, the findings of this study suggest applying increased caution when using topical anti-inflammatory therapy with subconjunctival triamcinolone in patients with goniodysgenesis. Additionally, the relationship between glaucoma and vision loss was not evaluated. Rescue topical anti-inflammatory therapy was not standardized, introducing variability, and eyes receiving rescue therapy remained in the no-topical-therapy group, potentially affecting outcomes. Nonetheless, the authors maintain that even though topical therapy was utilized for a proportion of eyes in the no-topical-therapy group, the duration, frequency and amount of topical therapy used in these cases was much lower than their counterpart eyes in the topical-therapy group. Additional limitations include the lack of evaluation of ocular and systemic comorbidities other than diabetes and the absence of evaluation of client compliance with topical treatment, both of which may have influenced results.

This study compared the post-phacoemulsification outcomes in dogs receiving subconjunctival triamcinolone with or without the use of topical anti-inflammatory therapy. The results suggest that subconjunctival triamcinolone may be an effective alternative to topical anti-inflammatory therapy, even though some patients may require topical intervention. Topical anti-inflammatory therapy given with subconjunctival triamcinolone increases the risk of glaucoma and vision loss in non-diabetic dogs, but does not impact these factors in diabetic dogs. Benefits of subconjunctival triamcinolone instead of topical anti-inflammatory therapy after phacoemulsification include reduced dependence on client compliance regarding surgical outcomes, lower cost, minimized environmental waste and decreased aftercare demands on clients, especially older or physically limited clients. This treatment also provides an option for patients that do not tolerate topical therapy behaviorally.

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