

Evaluation of Aqueous Tear Production in Dogs Following General Anesthesia

Pre- and postanesthetic Schirmer tear test (STT) values were measured in 46 dogs. All subjects had normal preanesthetic STT values (18.3±2.8 mm per min in the left eye [OS] and 18.3±3.0 mm per min in the right eye [OD]). Significant differences were found between pre- and postanesthetic STT values. Significant decreases in tear production were evident for up to 24 hours following the anesthetic event. Subject age did not significantly influence the results. Duration of anesthesia significantly affected the rate of return to preanesthetic STT values, with anesthetic events greater than two hours in duration having a prolonged effect as compared to anesthetic events less than two hours in duration. Anticholinergic administration prior to or during anesthesia further lowered postanesthetic STT values. *J Am Anim Hosp Assoc* 2000;36:427-30.

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Introduction

Normal aqueous tear production in the dog, as measured by the Schirmer tear test (STT), has been reported as 19.8 (± standard deviation [SD] 5.3) and 21 (± SD 4.2) mm strip wetting per minute.^{1,2} Tear production in the dog has been documented to fluctuate significantly on a day-to-day and week-to-week basis.^{3,4} Several causes of keratoconjunctivitis sicca (KCS) have been documented in the dog; the most common include autoimmune, drug-induced, and neurogenic etiologies.⁵⁻⁸ In addition, general anesthesia has been documented to decrease aqueous tear production in humans, dogs, and horses.⁹⁻¹² Whether xerophthalmia is evident only during the anesthetic event or if it actually persists for some period beyond the anesthetic event has not been fully evaluated.

There are clinical consequences to anesthesia-induced decreases in tear production. Corneal ulceration associated with general anesthesia is common, especially when adequate corneal lubrication is not employed. This is likely due to corneal exposure and drying during and after anesthesia, although trauma may play a role in some cases.¹³ Since the duration of the decreased tear production associated with general anesthesia is not known, it is difficult to accurately interpret the significance of postanesthetic ophthalmic findings, such as mucoid ocular discharge and decreased STT values, in animals that have recently undergone anesthesia.

The purposes of the study reported here were to determine the incidence and duration of postanesthetic xerophthalmia in normal dogs and to attempt to identify the variables that might influence the findings.

Materials and Methods

Forty-six dogs admitted to the Virginia-Maryland Regional College of Veterinary Medicine Teaching Hospital for various procedures requiring general anesthesia were studied. Prior to inclusion in the study, slit-lamp biomicroscopy was performed on each animal to ensure that no detectable ocular surface disease was present. To rule out pre-existing KCS, a baseline STT value was obtained on each dog. Only dogs with baseline STT values of 15 mm per minute or greater in both eyes (OU) were included. Due to the frequent administration of topical medications in ophthalmic cases, animals undergoing ophthalmic procedures were excluded from the study. Animals receiving medications that have been proven or suspected to influence tear

production (e.g., sulfonamides) were also excluded. Recorded variables included signalment, presenting condition, current medications, anesthetic regimen (including the use of anticholinergics), duration of anesthesia, and administration of postanesthetic analgesics.

Preanesthetic STT values OU were recorded for all subjects. Postanesthetic STT values were obtained at six, 12, 24, 36, and 48 hours following the conclusion of anesthesia. Each subject was tested according to this time schedule until that individual's STT value reached 15 mm per minute or greater OU. Because inconsistencies in the absorptive capacity of Schirmer strips from different manufacturers and lot numbers have been identified, Schirmer tear test strips^a from the same manufacturer and lot number were used for each study subject.¹⁴ Prior to testing, the inferior cul-de-sac was gently swabbed with a cotton-tipped applicator to remove mucus, which might alter the test result, and to absorb the lacrimal lake so that tear production was measured as opposed to tear accumulation. When performing the tests, the Schirmer strips were consistently placed in the inferior cul-de-sac at the junction of the middle and temporal third of the lower lid. All tests were performed by the same individual (Herring).

For data analysis, dogs were assigned to one of three age categories: young (less than two years), middle-aged (two to seven years), and old (greater than seven years). Dogs were also assigned to one of three groups based on duration of anesthesia. These groups included anesthetic events of short duration (less than two hours), moderate duration (two to four hours), and long duration (greater than four hours). Additionally, dogs were assigned to one of two groups based on whether or not they had received systemic anticholinergic medication prior to or during anesthesia.

Statistical Analysis

Statistical analysis was performed using multivariate repeated measures analysis of variance. Differences were considered to be significant if *p* was 0.05 or less. During data collection, STT measurements were halted once a subject's postanesthetic tear production reached 15 mm per minute OU. When required during analysis, each subject's preanesthetic STT values were used for data points beyond the last actual measurement.

Results

Thirty-eight dogs in the study were purebred dogs of 23 various breeds, and eight were mixed-breed dogs. Ages of dogs ranged from four months to 11 years, with a mean age of 4.3 years. Included in the study were 12 males, nine neutered males, nine females, and 16 spayed females. Mean baseline STT values were $18.3 \pm \text{SD } 2.8$ mm per minute for the left eye (OS) and $18.3 \pm \text{SD } 3.0$ mm per minute for the right eye (OD).

Due to the large number of different breeds represented in the study group, the influence of breed on the results could not be ascertained. Similarly, due to variability in anesthetic

protocols and postanesthetic medications, the effects of these variables could not be ascertained.

Overall Effect of Anesthesia

The interaction of postanesthetic time versus STT values was examined. Schirmer tear test values OU differed significantly from baseline at the six-, 12-, and 24-hour postanesthetic measurements (*p* equal to 0.0001, 0.0001, and 0.01, respectively) [Figure 1]. Mean STT values at these times, respectively, were 6.8 mm per minute (range, 0 to 19 mm per min), 11.7 mm per minute (range, 0 to 20 mm per min), and 15.8 mm per minute (range, 4 to 19 mm per min).

Age

This study included 13 young, 19 middle-aged, and 14 old dogs. There was no significant interaction between age groups of the subjects and time to normal tear production values (*p* equal to 0.71 and 0.40 for OS and OD, respectively).

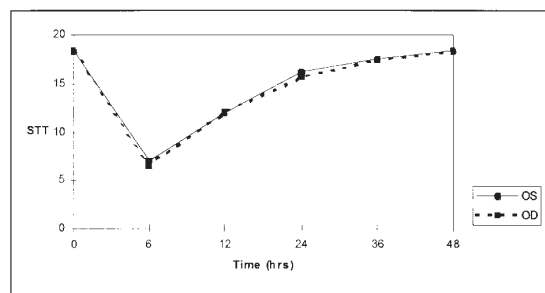


Figure 1—Mean pre- (time 0) and postanesthetic Schirmer tear test (STT) values for left (OS) and right (OD) eyes of 46 dogs undergoing general anesthesia. (Schirmer tear test expressed in mm per min.)

Duration of Anesthesia

There were nine subjects in the short duration category, 24 subjects in the moderate duration category, and 13 subjects in the long duration category. There were no significant differences in the preanesthetic STT values between these groups (*p* equal to 0.47 and 0.42 for OS and OD, respectively). There was a significant effect of the duration of anesthesia on postanesthetic STT values OU (*p* equal to 0.02 and 0.04 for OS and OD, respectively) [Figure 2]. Postanesthetic STT values OS for dogs in the moderate and long duration groups were significantly lower than values OS for dogs in the short duration group through the 24-hour postanesthetic measurement (*p* less than 0.05). Postanesthetic STT values OD for dogs in the moderate and long duration groups were significantly lower than values OD for dogs in the short duration group at the six-hour postanesthetic measurement (*p* less than 0.05). At the 12- and 24-hour measurements, dogs in the long duration group had significantly lower STT values than dogs in the short duration group (*p* less than 0.05), but there were no significant differences between the short

and moderate duration groups. Dogs in the short duration group returned to normal tear production more rapidly than dogs in the other two groups. There were no significant differences in STT values between the moderate and long duration groups at any measurement period.

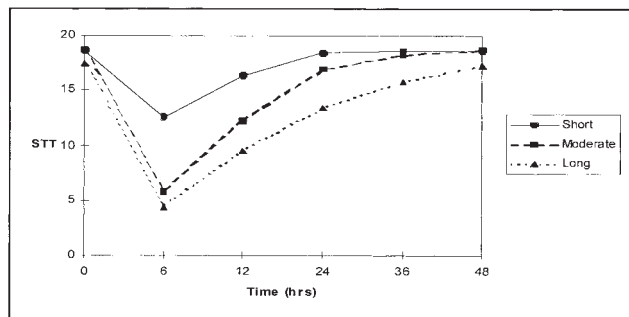


Figure 2—Mean pre- (time 0) and postanesthetic Schirmer tear test (STT) values in 46 dogs undergoing general anesthesia, with data grouped according to duration of anesthesia. Schirmer tear test values for right (OD) and left (OS) eyes are averaged. (Schirmer tear test expressed in mm per min.)

Anticholinergic Administration

Thirty subjects were administered the anticholinergic glycopyrrolate either as a preanesthetic agent or during anesthesia. Sixteen subjects received no anticholinergic agent. A significant interaction was found between the overall time to normal tear production and the administration of anticholinergics for OD but not OS (p equal to 0.33 and p equal to 0.02 for OS and OD, respectively). In addition, contrast analysis revealed significant differences between the treated and untreated groups at the six-, 12-, and 24-hour measurements OU. At these time intervals, dogs that had been treated with anticholinergics had significantly lower STT values than untreated dogs (p less than 0.05) [Figure 3].

Discussion

General anesthesia dramatically decreases aqueous tear secretion in humans, dogs, and horses.⁹⁻¹² In one study of cats anesthetized with ketamine and acetylpromazine, only those cats that were premedicated with atropine had significant decreases in tear production during anesthesia.¹⁵ A study which evaluated STT values in dogs undergoing general anesthesia with and without atropine premedication revealed that STT values for dogs in both groups approached 0 mm per minute following one hour of anesthesia, although STT values for dogs in the atropinized group fell more rapidly.¹⁰ Additionally, anticholinergics have been documented to decrease tear production in the dog following both topical and systemic administration.^{2,10,11,16}

The results of this study show that general anesthesia has a prolonged, deleterious effect on tear production in the dog. Schirmer tear test values were significantly lower than baseline measurements for up to 24 hours after anesthesia. Although daily and weekly fluctuation in tear production has

been documented in normal dogs, it is unlikely to account for the findings in this study.^{3,4} In this study, subject age did not appear to influence the postanesthetic STT values. Dogs that underwent a short anesthetic event (i.e., less than two hours) returned to normal tear production more rapidly than dogs that underwent anesthesia of moderate or long duration. Also, dogs treated with anticholinergic agents had significantly lower postanesthetic STT values than did untreated dogs. The overall time to return to normal tear production was lengthened by anticholinergic administration for OD, but not OS. The reason for this difference between eyes is unclear, but it is unlikely to hold any clinical significance.

The results of this study have several clinical implications. The current recommendation for corneal lubrication during general anesthesia in dogs is for bland ophthalmic ointment to be applied to the cornea every 90 minutes for the duration of anesthesia.¹¹ Although this interval is appropriate and sufficient during the anesthetic episode, additional consideration should be given to select cases during the postanesthetic period. Whereas most dolichocephalic and mesocephalic dogs have some degree of protection from corneal exposure due to the anatomic depth of their orbits and their ability to use the third eyelid to cover their corneas, brachycephalic or lagophthalmic animals are more prone to developing corneal problems (e.g., ulceration) that may be compounded by transient xerophthalmia. Periodic application of lubricant ointment for the first 24 to 36 hours following anesthesia would be prudent in all dogs, with particular attention given to brachycephalic and lagophthalmic patients.

In dogs that develop mucoid or mucopurulent discharge, decreased STT values, or both, and have recently undergone general anesthesia, the results of this study would suggest that if 24 hours or less have elapsed since an anesthetic event, abnormally low STT values may be related to the anesthesia. Failure to consider this prolonged effect of anesthesia on STT values in the dog might result in misdiagnosis of KCS, with potential prescription of unwarranted medical therapy.

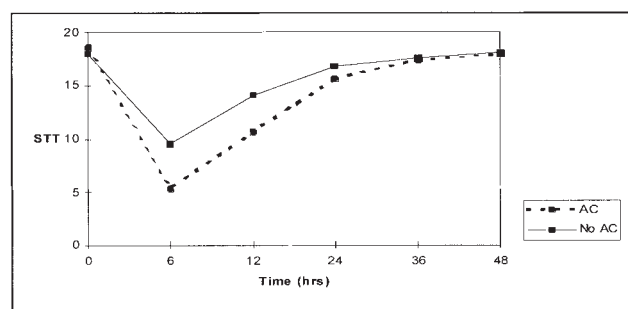


Figure 3—Mean pre- (time 0) and postanesthetic Schirmer tear test (STT) values for 46 dogs that received (AC) or did not receive (No AC) anticholinergic medication as part of their anesthetic protocol. Schirmer tear test values for right (OD) and left (OS) eyes are averaged. (Schirmer tear test expressed in mm per min.)

Clinicians should monitor STT values in such patients to ensure that tear production returns to normal following the anesthetic event.

^a Alcon Schirmer Tear Test Strips; Alcon Laboratories, Fort Worth, TX

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