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Effects of 0.15% Sodium Hyaluronate and 0.5% Sodium Carboxymethylcellulose Eye Drops on Schirmer Tear Test I Values in Shih Tzu Dogs During Bathing

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Short Report

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Abstract

Routine bathing is an essential component of canine grooming but may expose the ocular surface to chemical, thermal, and mechanical stimuli capable of disrupting tear film homeostasis. This study evaluated the effects of prophylactic administration of eye drops containing 0.15% sodium hyaluronate or 0.5% sodium carboxymethylcellulose on aqueous tear production in Shih Tzu dogs undergoing routine bathing and drying. Forty clinically healthy Shih Tzu dogs were randomly allocated into four groups (n = 10): 0.15% sodium hyaluronate, 0.5% sodium carboxymethylcellulose, sterile saline solution (placebo), and an untreated control. Tear production was assessed using the Schirmer tear test I (STT-I) immediately before treatment and immediately after bathing. Data were analyzed using the Shapiro–Wilk test, paired t-test, and one-way analysis of variance (ANOVA). Mean STT-I values increased after bathing in all experimental groups. However, statistically significant increases were observed only in dogs receiving sodium hyaluronate (P = 0.0092) and sodium carboxymethylcellulose (P = 0.0396), whereas no significant changes were detected in the placebo (P = 0.1264) or untreated control group (P = 0.1126). No significant differences were observed among groups after bathing (ANOVA, P = 0.134). These findings indicate that prophylactic ocular lubrication with sodium hyaluronate or sodium carboxymethylcellulose was associated with significant within-group increases in aqueous tear production following bathing, without evidence of superiority over placebo or no treatment. Further studies incorporating complementary ocular surface assessments are needed to determine whether prophylactic lubrication provides protective benefits during routine grooming.

1 INTRODUCTION

Routine bathing is an integral part of companion dog care, particularly in breeds requiring frequent coat maintenance, such as the Shih Tzu. However, exposure to shampoos, water, and warm air during drying may cause ocular surface irritation and tear film alterations, potentially compromising corneal and conjunctival integrity (Fayad 2023).

Brachycephalic dogs, particularly Shih Tzus, exhibit anatomical features that increase ocular surface exposure, including shallow orbits, exophthalmos, enlarged palpebral fissures, and incomplete eyelid closure. These characteristics may impair tear film distribution and stability, increasing susceptibility to exposure keratopathy and corneal ulceration (Marchini et al. 2024; Sebbag et al. 2023; Sebbag and Sanchez 2023). In this context, prophylactic ocular lubrication represents a potential strategy to reduce friction and maintain ocular surface hydration during grooming procedures (Bedos et al. 2023; Bielory and Wagle 2017; Srinivasan et al. 2023).

Among available ophthalmic lubricants, sodium hyaluronate exhibits viscoelastic properties and high water-retention capacity, whereas sodium carboxymethylcellulose acts as a bioadhesive polymer that promotes formulation retention on the ocular surface (Agashe et al. 2025; Cuomo et al. 2024). Aqueous tear production can be assessed using the Schirmer tear test I (STT-I), which is widely employed in the clinical evaluation of lacrimal function in dogs (Iwashita et al. 2023; Nascimento et al. 2023). The use of

STT-I in brachycephalic dogs has also been specifically investigated, including the influence of eyelid position during testing (Pe'er et al. 2024). Despite the clinical use of these lubricants, experimental evidence regarding their effects on tear production during routine bathing and drying remains limited.

Therefore, this study aimed to evaluate the effects of prophylactic administration of 0.15% sodium hyaluronate and 0.5% sodium carboxymethylcellulose eye drops on aqueous tear production, measured by STT-I, in Shih Tzu dogs undergoing routine bathing and drying.

2 MATERIALS AND METHODS

A prospective, controlled field study was conducted between March and May 2025 at a commercial grooming facility in Teresina, Piauí, Brazil, under routine grooming conditions. The sample comprised the first 40 consecutively enrolled privately owned Shih Tzu dogs of either sex that met the eligibility criteria. Written informed consent was obtained from all owners. Before enrollment, each dog underwent a general physical examination and a basic ophthalmic examination by the same veterinarian, including inspection of the periocular region, eyelids, conjunctiva, cornea, and sclera, without prior administration of diagnostic dyes, topical anesthetics, or ophthalmic medications. Only clinically healthy dogs without detectable ocular abnormalities were included. Dogs with epiphora, ocular discharge, blepharospasm, moderate to severe conjunctival hyperemia, corneal abnormalities, eyelid disorders, conjunctivitis, previously diagnosed keratoconjunctivitis sicca, or other conditions potentially affecting tear production were excluded.

Dogs were randomly allocated to four groups (n = 10 per group). Baseline aqueous tear production was measured in both eyes using Schirmer tear test I (STT-I) strips (DrogaVET®, Brazil), placed in the lower conjunctival fornix for 60 s. Subsequently, one drop of the assigned formulation was instilled into each eye: G1, 0.15% sodium hyaluronate (Hyabak®, Laboratoires Théa, France); G2, 0.5% sodium carboxymethylcellulose (Lacri®, Agener União Saúde Animal, Brazil); G3, sterile 0.9% saline solution (placebo); and G4, no ophthalmic treatment. All dogs underwent bathing with the same commercial canine shampoo, followed by drying performed by the same groomer using the same hair dryer at a medium temperature setting. Immediately after bathing and drying, STT-I was repeated in both eyes using the baseline protocol. All measurements were performed by the same veterinary ophthalmologist, who remained blinded to group allocation.

The study was approved by the Animal Ethics Committee of Centro Universitário Santo Agostinho (CEUA/UNIFSA; protocol no. 109575/25) on 25 February 2025. All procedures complied with Brazilian legislation and the guidelines of the National Council for the Control of Animal Experimentation (CONCEA).

Statistical analyses were performed using R (R Foundation for Statistical Computing, Vienna, Austria). For each dog, the mean STT-I value of both eyes was calculated before and after bathing and used as the unit of analysis. Data normality was assessed using the Shapiro–Wilk test. Within-group pre- and post-bathing differences were evaluated using paired t-tests. Post-bathing mean STT-I values were compared

among groups using one-way analysis of variance (ANOVA), after assessing residual normality and homogeneity of variances using the Shapiro–Wilk and Levene's tests, respectively. Statistical significance was set at $P < 0.05$.

3 RESULTS

Mean Schirmer tear test I (STT-I) values before and after bathing, including measurements from the right and left eyes and the mean value per dog, are presented in Table 1. Mean aqueous tear production increased after bathing in all four experimental groups. In dogs treated with 0.15% sodium hyaluronate (G1), mean STT-I values increased from 21.5 ± 5.7 to 23.8 ± 6.0 mm/min, whereas those receiving 0.5% sodium carboxymethylcellulose (G2) showed an increase from 17.6 ± 5.0 to 20.1 ± 5.6 mm/min. The placebo group (G3) exhibited an increase from 14.9 ± 4.7 to 17.6 ± 4.9 mm/min, while the untreated control group (G4) increased from 18.6 ± 7.8 to 20.6 ± 7.3 mm/min.

Table 1
Mean (± SD) STT-I values before and after bathing in Shih Tzu dogs according to treatment group.

Group	Treatment	Right Eye (RE) Before Bathing	Right Eye (RE) After Bathing	Left Eye (LE) Before Bathing	Left Eye (LE) After Bathing	Mean STT-I (± SD) Before bathing	Mean STT-I (± SD) After bathing	Paired t-test (P value)
G1	0.15% SH	20.7 ± 5.4	23.2 ± 6.3	22.3 ± 6.1	24.1 ± 5.7	21.5 ± 5.7	23.8 ± 6.0	−3.30 (p = 0.0092) *
G2	0.5% SC	17.3 ± 4.9	19.9 ± 5.7	18.4 ± 5.1	20.5 ± 5.4	17.6 ± 5.0	20.1 ± 5.6	−2.40 (p = 0.0396) *
G3	Placebo (0.9% Saline)	13.4 ± 4.5	17.2 ± 4.7	16.5 ± 4.8	18.1 ± 5.2	14.9 ± 4.7	17.6 ± 4.9	−1.68 (p = 0.1264)
G4	Untreated control	18.0 ± 8.6	19.9 ± 7.2	19.1 ± 7.1	21.2 ± 7.4	18.6 ± 7.8	20.6 ± 7.3	−1.76 (p = 0.1126)

* Statistically significant difference between pre- and post-bathing STT-I values (paired t-test).

RE = Right Eye; LE = Left Eye; SH = Sodium Hyaluronate; SC = Sodium Carboxymethylcellulose.

Paired comparisons revealed statistically significant increases in mean STT-I values in G1 ($t = -3.3045$; $P = 0.0092$) and G2 ($t = -2.4045$; $P = 0.0396$). Although mean values also increased in G3 ($t = -1.6843$; $P = 0.1264$) and G4 ($t = -1.7579$; $P = 0.1126$), these changes did not reach statistical significance. The overall changes in mean STT-I values across groups are illustrated in Fig. 1.

The distributions of STT-I values by eye and experimental group are shown in Fig. 2. Before bathing (Fig. 2a), mean values were numerically higher in the left eye than in the right eye across all groups. G1 exhibited the highest baseline mean values, whereas G3 showed the lowest, particularly in the right eye (13.4 ± 4.5 mm/min). Outlying observations were identified in some groups, reflecting variability in individual measurements. After bathing (Fig. 2b), mean values increased in both eyes across all groups, while descriptive differences between groups and variability in individual measurements persisted. Lower outlying observations were identified in G2, G3, and G4, along with one upper outlier in G2.

For the assessment of statistical assumptions, the reported Shapiro–Wilk P values across the four groups ranged from 0.2831 to 0.6656. In the between-group analysis, no statistically significant departures from residual normality (Shapiro–Wilk: $W = 0.9746$; $P = 0.4978$) or homogeneity of variances (Levene: $F = 2.5498$; $P = 0.0710$) were detected. One-way ANOVA revealed no statistically significant difference in post-bathing mean STT-I values among the four groups ($F(3, 36) = 1.979$; $P = 0.134$). The estimated partial η^2 was 0.09.

4 DISCUSSION

The present study demonstrated an increase in mean Schirmer tear test I (STT-I) values after bathing in all four experimental groups, with statistically significant within-group increases observed only in dogs treated with 0.15% sodium hyaluronate or 0.5% sodium carboxymethylcellulose. However, the comparison of post-bathing values among groups revealed no statistically significant difference. These findings indicate that aqueous tear production increased after grooming but do not establish the superiority of either lubricant over placebo or no treatment.

The increase in STT-I values across all groups may be associated with reflex lacrimal secretion triggered by ocular surface stimulation during bathing and drying. Contact with water, temperature changes, airflow from the dryer, and manipulation of the periocular region may stimulate sensory endings associated with the ophthalmic branch of the trigeminal nerve. Activation of these afferent pathways can elicit autonomic responses that stimulate lacrimal secretion and increase blinking, potentially contributing to transient changes in tear production. This interpretation is consistent with the physiological mechanisms described by Vereertbrugghen and Galletti (2022), although these pathways were not directly investigated in the present study.

In the lubricant-treated groups, the significant increases in STT-I values may be considered in relation to the physicochemical properties of the formulations. Sodium hyaluronate is a glycosaminoglycan with high water-retention capacity and viscoelastic properties that support ocular surface hydration and lubrication (Cuomo et al. 2024). Sodium carboxymethylcellulose, in turn, exhibits bioadhesive characteristics that promote formulation retention on the ocular surface and contribute to lubrication (Agashe et al. 2025). Although these properties support their clinical use, the present findings do not establish whether the increases in STT-I values resulted from formulation-specific effects or from physiological responses to grooming-related stimuli.

The placebo and untreated control groups also showed numerical increases in tear production, although the paired comparisons were not statistically significant. This pattern supports the possibility that the grooming procedure itself contributed to the observed response. During bathing, shampoo components may come into contact with the periocular region and induce irritation, even without direct ocular application (Lazzarini et al. 2020). Experimental studies have shown that certain surfactants, including sodium laureth sulfate, can compromise corneal epithelial integrity and cause ocular irritation (Matsuda et al. 2009), while evaluations of commercial veterinary shampoos have identified varying degrees of ocular discomfort depending on product composition (Petit et al. 2017). In addition, exposure to warm air during drying may promote tear film evaporation and stimulate compensatory lacrimal secretion (Abusharha et al. 2016). These factors provide physiologically plausible explanations for the observed increases, although their individual contributions could not be determined.

The clinical relevance of these findings should be considered in light of the anatomical characteristics of Shih Tzu dogs. Brachycephalic conformation, characterized by shallow orbits, exophthalmos, enlarged palpebral fissures, and incomplete eyelid closure, increases ocular surface exposure and may impair tear film distribution and stability (Sebbag et al. 2023; Sebbag and Sanchez 2023). These characteristics highlight the importance of ocular care during procedures involving periocular manipulation, exposure to grooming products, and airflow. In this context, prophylactic ocular lubrication represents a potentially useful approach, although its effectiveness in preventing ocular injury during bathing remains to be demonstrated.

From a clinical perspective, the findings contribute to understanding immediate changes in tear production in Shih Tzu dogs undergoing routine bathing and drying. The significant within-group increases observed in lubricant-treated dogs warrant further investigation of prophylactic ophthalmic lubrication under these conditions. Nevertheless, the absence of a statistically significant between-group difference prevents recommending either formulation as superior to placebo or no treatment based on this study alone. Furthermore, increased aqueous tear production should not be interpreted as direct evidence of improved tear film stability or protection against ocular surface damage.

Several limitations should be acknowledged. Tear production was assessed only immediately before and after a single bathing session, preventing evaluation of the duration of the observed changes. Ophthalmic assessment was limited to STT-I measurements, without complementary tests such as tear film break-up time, fluorescein staining, tear osmolarity, or ocular surface cytology. Moreover, between-group comparisons were based on post-bathing values without adjustment for baseline differences, limiting interpretation of potential treatment effects. The sample size of ten dogs per group should also be considered, particularly given the variability in individual measurements. Future studies involving larger samples, repeated bathing sessions, additional assessment times, and complementary ocular surface examinations may help clarify the effects of these lubricants and their potential contribution to ocular protection during grooming procedures.

5 CONCLUSION

Prophylactic ocular lubrication before routine bathing was associated with significant increases in STT-I values in Shih Tzu dogs receiving sodium hyaluronate or sodium carboxymethylcellulose, whereas placebo or no treatment did not result in statistically significant changes. However, no significant differences were observed among the four groups after bathing, preventing confirmation of the superiority of either lubricant. These findings suggest that prophylactic ocular lubrication may influence the aqueous tear response during grooming procedures, although its protective effects on the ocular surface remain to be established. Further studies incorporating complementary ocular surface assessments are warranted.

Declarations

Competing interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Author Contribution

AAC: Conceptualization, methodology, investigation, data analysis, and writing of the original draft. JAS: Methodology, data interpretation, and critical review and editing of the manuscript. SMRC: Investigation, data collection, and review and editing of the manuscript. All authors read and approved the final version of the manuscript.

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Data Availability

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

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Figures

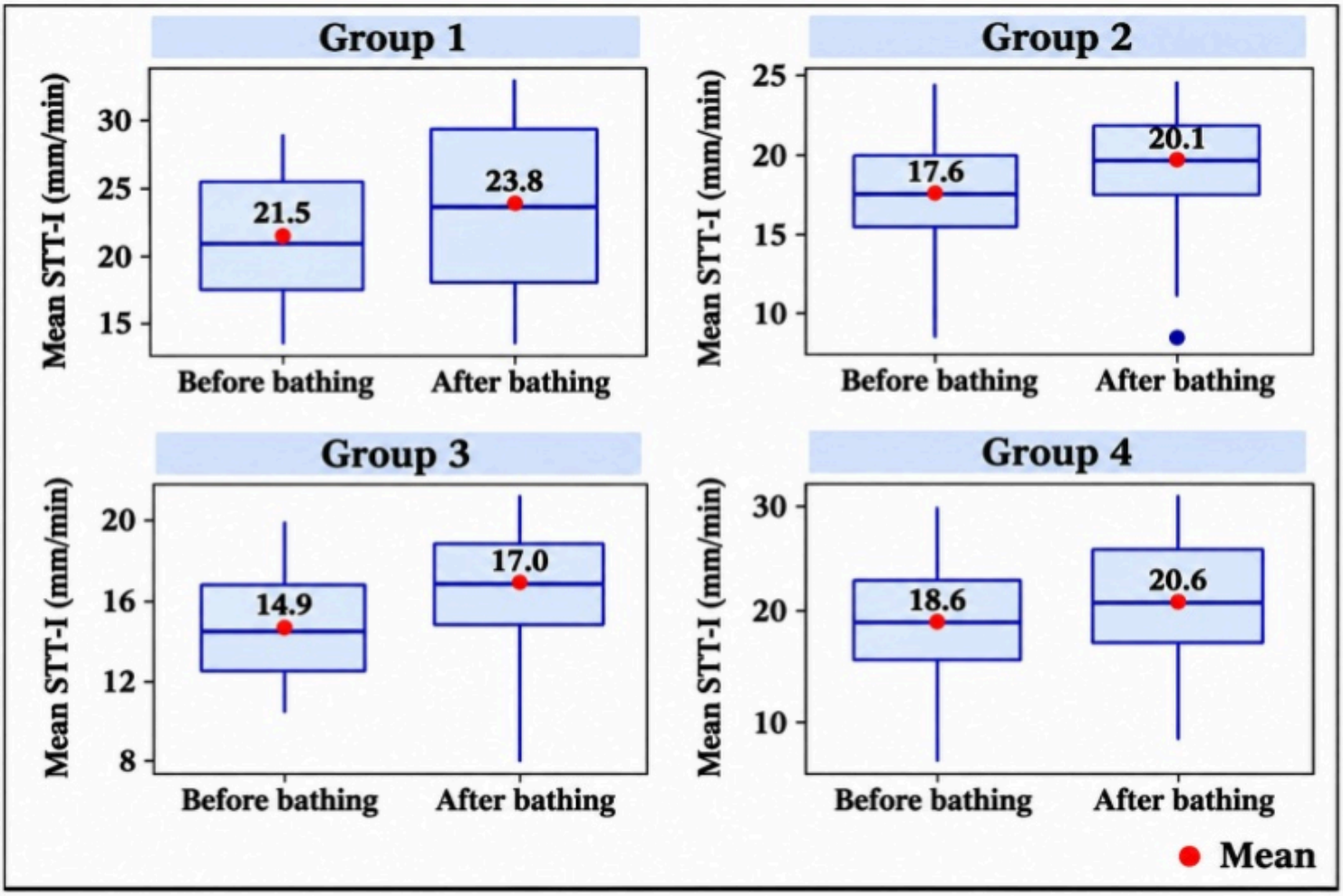


Figure 1

Mean Schirmer tear test I (STT-I) values before and after bathing in Shih Tzu dogs according to treatment group.

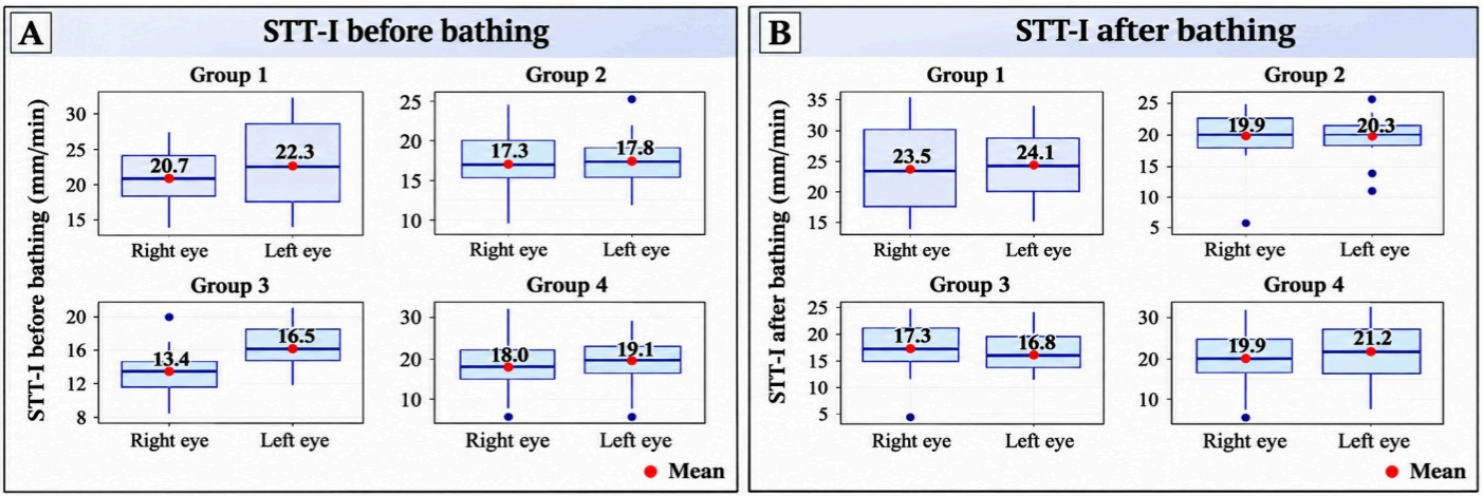


Figure 2

Distribution of Schirmer tear test I (STT-I) values in the right and left eyes of Shih Tzu dogs according to treatment group: (a) before bathing and (b) after bathing.