Subpalpebral lavage placement for remote topical administration of ocular medications in 12 dogs

Received: 6 December 2021 | Revised: 25 September 2022 | Accepted: 26 September 2022

DOI: 10.1111/vop.13029

ORIGINAL REPORT

WILEY

Subpalpebral lavage placement for remote topical administration of ocular medications in 12 dogs: A retrospective review and assessment of owner perception

Josie Parker[1] | **Joy Ioannides**[2] | **Vim Kumaratunga**[3] | **Juliette Preston**[3] | **Claudia Hartley**[1] | **David Donaldson**[3]

[1]Ophthalmology Department, Hospital for Small Animals Royal (Dick) School of Veterinary Studies, University of Edinburgh, Roslin, UK

[2]Optivet Referrals, Havant, UK

[3]Ophthalmology Department, The Queen Mother Hospital for Animals, Royal Veterinary College, Hatfield, UK

Correspondence
Josie Parker, Ophthalmology Department, Hospital for Small Animals Royal (Dick) School of Veterinary Studies University of Edinburgh, Roslin EH25 9RG, Scotland, UK.
Email: josie.parker@ed.ac.uk

Abstract

Objective: The aim of this study was to describe the placement of subpalpebral lavage (SPL) systems in 12 dogs (15 eyes) intolerant of topical ocular medications to assess the suitability, complications encountered and owner perception of use.

Animals Studied: Retrospective review of dogs that underwent SPL placement for treatment of ocular disease at the Ophthalmology Department, University of Bristol Small Animal Hospital between 2017 and 2021.

Procedure(s): Data recorded included signalment, history, diagnosis, treatment, reason for SPL placement, uni- or bilateral placement, duration of placement, complications, and outcome. Owner perception was assessed using an online questionnaire. Statistical analysis included McNemar and Wilcoxon signed-ranks tests.

Results: Twelve dogs (15 eyes) underwent SPL placement. Eleven owners completed the online questionnaire. Corneal ulceration was the most common disease requiring SPL placement ($n = 13/15$ eyes, 86.7%). Most cases received multimodal topical therapy ($n = 9/15$ eyes, 60.0%) via SPL. Owners administered medication 6.63 times daily via SPL (range 1–16 applications/day). All dogs requiring ongoing topical medication ($n = 8/12$, 66.7%) were trained to accept direct administration during SPL treatment. Statistically significant improvements in medication compliance, ease of application, and reduced perceived risk of iatrogenic ocular injury were reported by owners (p-value = .001, .004, and .031 respectively). Minor complications were infrequently reported but an excellent outcome was achieved for all eyes.

Conclusion: Subpalpebral lavage placement provides a practical and safe solution for the provision of frequent multimodal ocular medication when treating patients with a challenging temperament.

KEYWORDS

compliance, subpalpebral lavage

1 | INTRODUCTION

The application of topical eye drops is the cornerstone of treatment for many ocular diseases. This is generally well tolerated by the majority of patients but aggressive and fractious dogs can present a dangerous challenge to themselves and those administering the medication.

An inability to comply with topical eye drop regimes may be associated with therapeutic failure and attempts to medicate fragile eyes may lead to iatrogenic damage such as descemetocele rupture or ocular wound dehiscence. Attempts to treat aggressive patients may be associated with injury to the owner and negatively impacting the owner-pet relationship.

Poor medication compliance plays a major role in outcome and treatment failure[1] in human health care. Management of ophthalmic conditions is hindered by non-compliance with topical eye medication, even if there is a risk of significant consequences in sight-threatening diseases such as glaucoma.[2] Poor administration technique,[3] particularly in older patients and children[4–6] is often identified as a factor in ophthalmic medicine non-compliance.

Alternatives to direct application of medication include subconjunctival injections,[7] sustained release devices[8,9] and drug-loaded ophthalmic inserts[10,11] but are only available for a very limited range of medication and are uncommon in small animal veterinary practice.

A subpalpebral lavage (SPL) is a specialized ophthalmic catheter allowing remote delivery of non-viscous medication to the eye via a silicone tube. The tubing passes from a small footplate in the conjunctival fornix, through the eyelid to where it is secured onto the patient's head and terminates with a needle-free injection port. Topical medication is drawn up in a syringe and injected into the port followed by an air bolus to push the medication through the tubing to the reach the tear film.

Subpalpebral lavages are widely regarded as the most practical method of administering multiple ophthalmic medications to the equine eye in the short and medium term.[12–15] Medication can be safely and accurately administered to head-shy patients without the handler touching the patient's face or periocular area. They are routinely used in hospital and ambulatory settings. Owners can be trained to operate the SPL system allowing the patient to be managed at home. SPL use has been reported in humans,[16] llamas, and a harbor seal.[17] A single report[18] and a case series of four dogs[19] describe SPL use for management of corneal ulceration in dogs. However, a study of complications and owner compliance has not been described.

The aim of this study was to investigate placement of a subpalpebral lavage system in the ventral eyelid of dogs intolerant of direct administration of topical medications, to assess the suitability for use in patients with fragile eyes, complications encountered and owner perception of its ease of use.

2 | METHODS AND MATERIALS

2.1 | Retrospective review of medical records

The medical record database at Langford Vets Small Animal Hospital, University of Bristol, was searched to identify all clinical canine cases that underwent SPL placement between 2017 and 2021.

Only patients having undergone a complete ophthalmic examination performed by either an ECVO resident or diplomate were included in the study. Ophthalmic examination included neuro-ophthalmic evaluation, Schirmer tear test (STT-), slit-lamp biomicroscopy (Kowa SL-15, Kowa Company Ltd.), rebound tonometry (TonoVet®, Icare Finland Oy) indirect ophthalmoscopy (Vantage Plus, Keeler Ltd) and fluorescein test (I-Dew Flo, Entod Research Cell UK Ltd). Cases requiring sedation for a complete ophthalmic assessment were not excluded from the study.

The decision to place an SPL in each case was made under the direction of an ECVO diplomate.

The patient data obtained included the breed, age, sex, diagnosis, type of treatment (medical or surgical), reason for SPL placement, uni- or bilateral SPL placement, type of ocular medication administered via the SPL, maximum number of medications administered per day, duration of SPL placement, reported complications and treatment outcome.

2.2 | Assessment of owner perception

Owners of patients identified in the medical record search were asked to participate in an anonymous online questionnaire using Survey Monkey® (Survey Monkey Inc.) about their experiences and perception of the use of an SPL. Contact was made via email or telephone to explain the reason for performing the study and to inform the participants what was involved. Consent to participate was obtained at the first question of the survey. Cases were excluded from participating in the questionnaire if the SPL device was removed before discharge from hospital.

The questionnaire was divided into three parts (Appendix S1). The first two parts compared the owner's experience of applying eye drops directly onto the eye, prior to placement of the SPL with applying the eye drops using the SPL. This included questions regarding

compliance, ease of application, the dog's behavior while medication was applied, the perceived risk of injury to the eye during the application of the drops, the number of people required to administer eye medication, and the effect on the owner's bond with their dog during this experience. The third part of the questionnaire focused on the owner perception of using the SPL system. This included questions regarding how confident they felt administering the eye drops through the SPL system and if there was anything the owner liked or disliked about the SPL. Questions regarding the patient's behavioral issues, such as referral to a behavioral specialist, were also included. The responses were anonymous, and the questionnaire was available online for 6 weeks. The interval between SPL placement and completion of the survey was calculated from the time each patient's SPL was removed to the closing date of the survey.

2.3 | Statistical analysis

Data collected from medical records and the owner questionnaire was entered into an Excel spreadsheet (Microsoft® Excel for Mac Version 16.47). Analysis was performed using Excel and SPSS® software (IBM SPSS Statistics Version 27.0.1.0). Descriptive statistics were analyzed using standard methods. Questionnaire answers were compared using McNemar and Wilcoxon signed rank tests. Statistical significance was defined at $p < .05$.

2.4 | Ethics statement

Ethics approval for this study was obtained from the University of Bristol Faculty of Health Science Student Research Ethics Committee (Ref:111188) and the Animal Welfare and Ethical Review Body (VIN/20/033).

2.5 | Placement of an SPL in the ventromedial eyelid

Subpalpebral lavage placement was performed by an ECVO resident supervised by an ECVO diplomate.

All patients were heavily sedated or anesthetized and placed in sternal or lateral recumbency. The equipment required for SPL placement is detailed in Table 1. The lower eyelid and two small square areas corresponding to the sites of SPL suture placement were clipped and an aseptic surgical prep was performed.

Local anesthetic drops (Minims proxymetacaine hydrochloride 0.5% and Minims tetracaine hydrochloride 1.0%, Bausch and Lomb UK Limited) were applied to the eye following surgical preparation. In cases where the SPL placement was performed while under sedation, subcutaneous infiltration of 1% lidocaine hydrochloride (Hameln Pharma Ltd.) was injected up to a maximum cumulative dose of 6 mg/kg into the ventromedial eyelid and the other clipped areas.

TABLE 1 List of equipment required for placement of a subpalpebral lavage system.

Equipment required for placement of SPL under general anesthetic or sedation
Clippers
1:10 and 1:50 povidone-iodine solution
Gauze swabs
Topical local anesthetic (proxymetacaine or tetracaine)
Sterile gloves
Equivet SPL kit-8 French gauge (Kruuse UK Limited)
Nonabsorbable suture (2–0 or 3–0 Nylon)
Needle holders
Adhesive duct tape
Strapall tape
Marker pen
Adhesive cyanoacrylate glue
Chest harness
Buster collar
Additional equipment required for placement of SPL under sedation only
Lidocaine drawn up into three syringes with 25G needle

The trocar was positioned between the third eyelid and the lower medial lid (Figure 1A) and then passed through the conjunctiva at the deepest point of the ventromedial fornix, avoiding excessive contact or application of pressure to the globe (Figure 1B). The trocar tip was guided to emerge through the lower lid around 1 cm ventral to the orbital rim (Figure 1C). The trocar and tubing were gently pulled through the lid until the foot plate was positioned in the ventromedial fornix (Figure 2). The trocar was then removed from the tubing.

Three "butterfly" tabs were created using 5 cm pieces of adhesive duct tape (Vinyl Duct Tape 3903i, 3M™) and placed at the exit point of the tubing through the lower eyelid (Figure 3A,B). The butterfly tab was sutured in place on each side of the tubing using non-absorbable material (2–0 or 3–0 Ethilon™, Ethicon Inc.) using a horizontal mattress suture with the knot tied on the underside of the tab taking care to avoid puncturing the tubing with the suture needle (Figure 3C,D). The two remaining tabs were placed and sutured in the two clipped areas on the skin (Figure 3E).

The tubing was passed over the top of the head and down the neck to the chest harness. The tubing was attached on

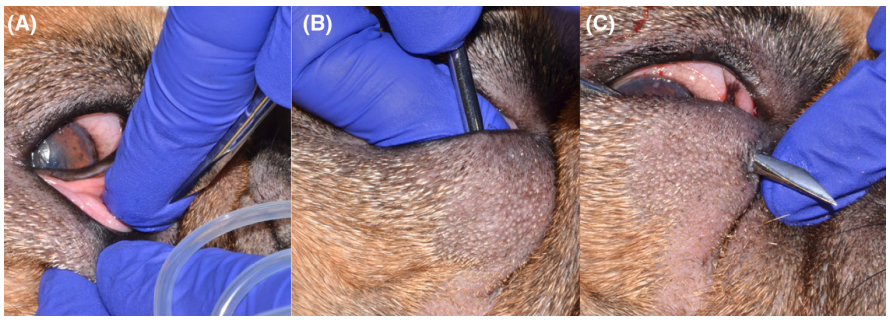

FIGURE 1 Placement of the SPL trocar. (A) The trocar is grasped using a pencil grip close to the sharp end with the bevel pointing down while holding the tubing in the palm of the hand. (B) The tip of the trocar is introduced, guarded by the index finger, into the lower conjunctival fornix ensuring placement of the trocar was between the third eyelid and the lower medial lid. (C) The trocar is then passed through the conjunctiva at the deepest point of the ventromedial fornix, avoiding excessive contact or application of pressure to the globe. The tip of the trocar is then walked through the subcutaneous tissue until it passes full thickness onto the skin surface of the ventromedial eyelid. The ideal exit point is around 1 cm ventral to the orbital rim.

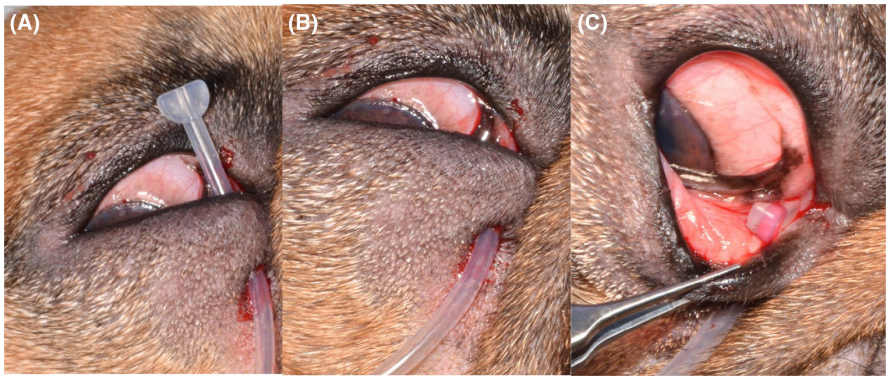

FIGURE 2 Positioning the SPL footplate. (A) Once the trocar has passed full thickness through the lower eyelid, the tubing gently pulled through until the foot plate is positioned in the ventromedial fornix. The trocar is then removed from the tubing. (B) The position of the footplate can be adjusted until it is well seated in the ventromedial fornix. When correctly placed, the foot plate should not be visible within the palpebral fissure. (C) Check the tubing is not twisted and the foot plate must sit between the lower eyelid and the third eyelid.

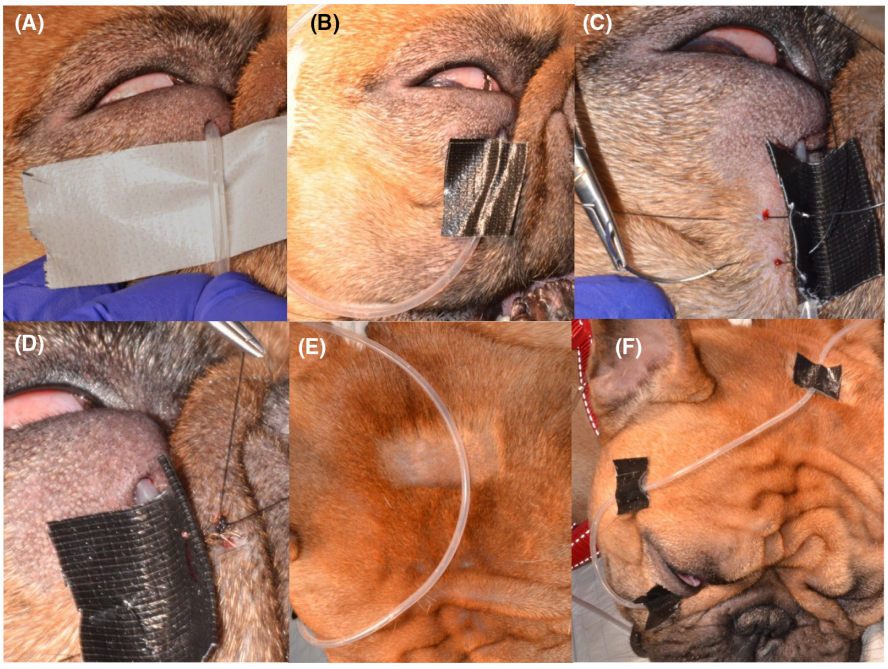

FIGURE 3 (A–E) Securing the SPL in position using adhesive duct tape and suture. (F) SPL tubing correctly secured in place with three butterfly tabs.

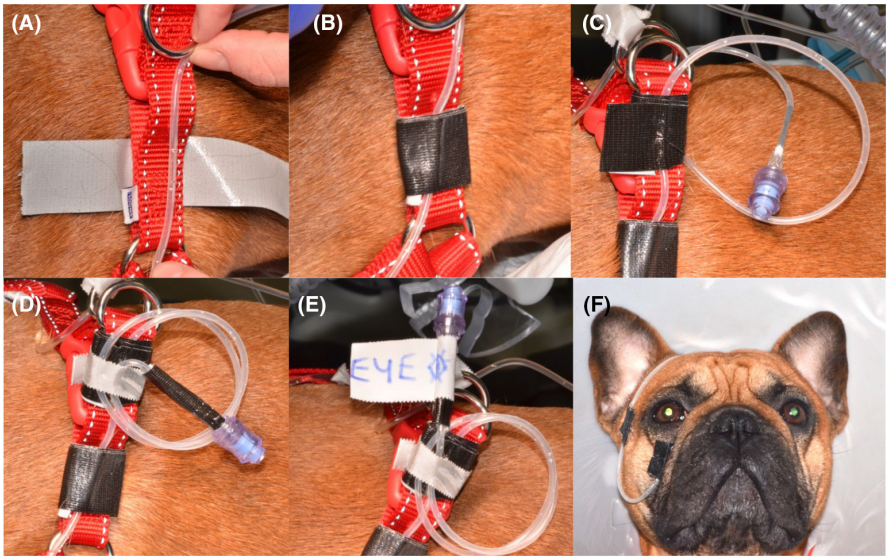

FIGURE 4 (A–E) Securing the SPL tubing in place onto the harness and preparing the injection port. (F) Appearance of the patient with a unilateral SPL in place once recovered from general anesthesia.

to the harness using adhesive tape (Figure 4A,B) and then trimmed to an appropriate length. A longer length of tubing was advantageous in very aggressive patients to maintain a safe distance between the patient and the person administering the medication. The blunt-ended cannula and needle-free injection port were placed into the open end of the tube (Figure 4C). Adhesive cyanoacrylate glue (Loctite®, Henkel Ltd.) was applied to the end of the tubing and adhesive tape was used to secure the catheter and port in place. Excess tubing was coiled and secured onto the harness with tape (Figure 4D). The injection port was labeled to differentiate between any intravenous long-line injection ports (Figure 4E). An Elizabethan collar was placed prior to recovery of the patient.

The patency of the SPL system was tested by injecting 5–10 ml of sterile saline followed with an air bolus of a similar volume. Topical ophthalmic medication solutions and suspensions were drawn up in a syringe and administered in a volume of 0.2 ml followed by 3–5 ml of air until the air bolus was witnessed arriving at the conjunctival footplate.

2.6 | Postoperative management and follow-up

All patients were discharged with an Elizabethan collar and a chest harness in addition to topical and oral medication. Owners were counseled prior to SPL placement with regard to the procedure, appearance of the device and how to administer eye medication with the aid of a photograph or a diagram. Administration of medication via the SPL was demonstrated to owners by an ECVO resident at the time of discharge from the hospital. Owners were asked to administer a bolus of medication via the SPL under supervision to ensure a correct technique was used. Written instructions detailing the patient's medication schedule and how to use the SPL system were also provided. Follow-up appointments were arranged based on the condition being treated in each patient.

3 | RESULTS

3.1 | Retrospective review of medical records

This retrospective study reviewed medical records of dogs that presented to Langford Vets Small Animal Hospital, University of Bristol, UK, between November 2018 and November 2020. Twelve dogs (15 eyes) that underwent SPL placement were identified and included in the study (Table 2).

The most common breed was the French Bulldog (n = 6/12, 50.0%). Tibetan Terriers, Shih Tzu, English Springer Spaniel, Rhodesian Ridgeback, Labrador Retriever, and English Bulldog represented single cases (n = 1/12, 8.3%). There were eight male dogs (66.6%; 4/8 were neutered) and four female dogs (33.3%; 2/4 were neutered). The mean age at the time of SPL placement, or at the time of the first placement if multiple SPLs were placed, was 4 years and 9 months with a range of 1 year to 13 years and 4 months.

The SPLs were placed while the patient was under general anesthesia in 10/12 (83.3%) dogs and under sedation in 2/12 (16.7%) dogs.

Subpalpebral lavage placement was bilateral in three out of 12 dogs (25.0%) and nine cases were placed unilaterally (75.0%). Three out of nine unilateral cases were placed

in the right eye (3/9; 33.3%), and 6/9 were placed in the left eye (66.7%). The most common reason for SPL placement was due to intolerance of direct application of topical eye medication (11/12 dogs; 91.7%). The average time from the initial prescription of eye drops to placement of the SPL was 17.2 days (range 0–75 days). Case 10 suffered from a severe anxiety due to ongoing otitis externa that manifested as aggression when applying ear medication. The owner felt medication with eye drops would not be possible and opted to place the SPL pre-emptively before starting eye drop treatment. The mean duration of SPL placement was 23.9 days with a range of 6–72 days.

The mean duration of hospitalization from placement of the SPL to the time of discharge was 5 days (range 0–29 days). The mean follow-up time from placement of the SPL was 145.9 days (range 15–902 days). On average, the number of rechecks performed from placement to removal of the SPL was 3.4 (range 1–6). The mean time to the first recheck appointment following discharge from the hospital was 4.6 days. The second recheck was performed on average at 11.3 days, the third recheck was 21.9 days, the fourth was 30.8 days, the fifth was 31 days, and the sixth was 38 days. Removal of the SPL was performed while the patient was conscious in 4/12 (33.3%) dogs and under sedation in 8/12 (66.7%) dogs.

Corneal ulceration was the most common disease requiring administration of eye drops in cases requiring SPL placement ($n = 13/15$ eyes, 86.7%). Case 10 received treatment for bilateral idiopathic uveitis (2/15 eyes; 13.3%). Superficial corneal ulcers (<50% stromal loss) were reported in 8/13 eyes (61.5%) and deep ulcers (>50% stromal loss) affected 5/13 eyes (38.4%). Conditions associated with corneal ulceration included keratoconjunctivitis sicca (3/13 eyes; 23.1%), entropion (3/13 eyes; 23.1%), neurogenic keratoconjunctivitis sicca (nKCS) secondary to otitis media in (1/13 eyes; 7.7%), corneal endothelial degeneration (1/13; 7.7%), crystalline corneal dystrophy (1/13; 7.7%) and distichiasis (1/13; 7.7%).

A surgical procedure was performed in 12/15 eyes (80.0%). Only one eye (7.7%) with corneal ulceration did not undergo a surgical treatment (case 9). The most common surgical procedures that were performed included a conjunctival graft (5/12; 41.7%) followed by a corrective eyelid blepharoplasty (3/12 eyes; 25.0%). Conjunctival grafting procedures included a conjunctival pedicle graft (2/5; 40.0%), a conjunctival bridge graft (2/5; 40.0%), and a conjunctival advancement graft (1/5; 20.0%). Other surgical procedures included a superficial keratectomy and placement of a subconjunctival ciclosporin A implant (both 2/12; 16.7%). Single cases required a corneo-conjunctival transposition graft, cryotherapy, diamond burr debridement, and a thermal keratoplasty were also recorded (1/12; 8.3%). Three patients (3/12; 25.0%) had multiple procedures performed under the same general anesthetic, such as the placement of a conjunctival pedicle graft and subconjunctival ciclosporin A implant or cryotherapy.

Most cases received multimodal topical therapy (9/15 eyes, 60.0%) via the SPL. The most common medication prescribed was a topical antibiotic (11/15 eyes, 73.3%), including 0.5% chloramphenicol (Chloramphenicol Eye Drops, Martindale Pharma Ethypharm Group Company) in 7/11 (64%), 0.3% ofloxacin (Exocin™ Allergan Ltd.) in 3/11 (27.7%) and 0.3% ciprofloxacin hydrochloride (Ciloxan™ Alcon Novartis Pharmaceuticals UK Ltd.) in one case (9.1%). Topical lubrication was prescribed in 8/15 (53.3%) of eyes. Various preservative-free sodium hyaluronate-based topical lubricants were prescribed; the most used lubricant was 0.15% (Hyabak® eye drops, Thea Pharmaceuticals Ltd.) in 6/8 (75.0%), 0.4% (Clinitas Soothe® 0.5 ml unit dose, Altacor Ltd.) in 1/8 (12.5%), 0.2% (Hylo-forte™ eye drops, Scope Ophthalmics Ltd.) in 1/8 (12.5%), of cases. Heterologous serum was prescribed in 5/15 (33.3%) eyes, 0.02% tacrolimus (BOVA UK Ltd.), and 1% prednisolone acetate (Pred Forte™, Allergan Ltd.) were prescribed in 2/15 eyes (13.3%). Owners administered medication on average 6.63 times daily via SPL (range 1–16 applications/day).

Case 9 received treatment for a superficial corneal ulcer secondary to nKCS and required intensive topical lubrication to maintain a sufficient precorneal tear film to aid healing and maintain ocular comfort. A Graseby® MS26 syringe driver (Smiths Medical International Ltd.) was utilized as a continuous rate infusion pump to administer a constant delivery of Hyabak® lubricating drops to the eye during hospitalization. The syringe driver was attached to the patient's harness and was required for 17 days until the tear production responded to oral pilocarpine.

Eight dogs (66.7%) required ongoing topical medication due to the nature of their condition. All were trained to accept direct administration while the SPL was in place.

Minor complications occurred in 6/15 eyes (40.0%) and included butterfly tab replacement (3/15; 20.0%), tube slippage (1/15; 6.7%), tube repair (1/15; 6.7%) and dermatitis following removal of the tabs (1/15; 6.7%). Case 4 (1/15; 6.7%) required a revision surgery following dehiscence of a corneo-conjunctival transposition graft to repair a deep corneal ulcer: a conjunctival bridge graft was placed at the second surgery. However, this was related to a lack of owner compliance with using the protective buster collar leading to disruption of corneal sutures and SPL butterfly tabs, rather than a complication of using the SPL. Overall, an excellent outcome was achieved for all eyes in this study.

TABLE 2 Summary of the signalment, diagnosis, treatment, and SPL use of patients included in the study.

Patient No	Breed	Age (months)	Sex	Side of placement	Diagnosis	Surgical procedure	Restraint	Duration of SPL placement (days)
1	Tibetan terrier	4 years 10 months	FN	OU	KCS (OU), Superficial corneal ulcer (OD) Deep stromal ulcer (OS)	Conjunctival pedicle graft (OS), Subconjunctival ciclosporin A implant (OU)	GA	35
2	French bulldog	1 year	FE	OS	Deep stromal ulcer	Conjunctival pedicle graft	GA	10
3	English Bulldog	2 years 5 months	ME	OS	KCS, Deep stromal ulcer, lower lid entropion	Celsus Hotz blepharoplasty	GA	10
4	French Bulldog	4 years	MN	OS	Deep stromal ulcer	Corneo-conjunctival transposition (CCT), conjunctival bridge graft	GA	42
5	French Bulldog	4 years 8 months	MN	OD	Deep stromal ulcer	Conjunctival hood graft	GA	11 Discharged from the hospital after SPL removal
6	Labrador	13 years 4 months	MN	OU	Corneal endothelial degeneration, bulla rupture, stromal corneal ulcer	Thermal keratoplasty	Sedation GA	7 23
7	French Bulldog	3 years 4 months	ME	OD	Mid-stromal corneal ulcer, lipid keratopathy	Lamellar keratectomy	GA	16
8	Rhodesian Ridgeback	1 year 1 month	FE	OU	Superficial corneal ulcer, entropion (OU)	Temporary tacking sutures	GA	6
9	Shih tzu	3 years 11 months	FN	OS	Neurogenic KCS secondary to otitis media, superficial corneal ulcer	None	Sedation	72
10	English Springer Spaniel	8 years 7 months	ME	OU	Uveitis, chorioretinitis (OU)	None	Sedation	36
11	French Bulldog	7 years 3 months	MN	OS	SCCED	Lamellar keratectomy	GA	24
12	French Bulldog	2 years 7 months	ME	OS	Deep corneal ulcer (OS) distichiasis (OU)	Conjunctival pedicle graft (OS), cryotherapy (OU)	GA	14

3.2 | Owner questionnaire

Eleven owners were invited to participate in the online questionnaire, and all completed it. Case 5 was excluded as the SPL was removed prior to being discharged from the hospital. The mean time to survey completion following the placement of the SPL was 448 days (range 5–870 days). The responses are summarized in Table 3.

All owners (11/11; 100.0%) answered they were unable to apply medication directly onto their dog's eye for the recommended number of times per day and their dog's behavior prevented direct topical medication. Owners assigned a score (0 = very easy to 100 = impossible) to indicate how easy they found applying the eye drops directly onto the eye and via the SPL system. A statistically significant difference between the mean score given by participants when applying eye drops directly onto the eye (86.9; range 50–100) and using the SPL (24.5; range 0–87) was recorded (p-value .004).

Eight owners (72.7%) felt concern applying the eye drops directly could cause injury to the eye and 6/11 (54.5%) reported concern about injury to the dog. This contrasts with using the SPL, where only one participant (9.1%) was concerned about causing harm to the eye or their dog when using the SPL system. A significant difference was reported between the perceived risk of iatrogenic injury to the eye applying the drops directly and when using the SPL system (p-value .031) but the perceived risk of applying the drops and causing injury to the dog was not significant (p-value .219).

A minority of owners (2/11, 18.1%) expressed concern that applying the eye drops directly onto the eye could cause themselves injury, but none shared this concern when applying the drops through the SPL system.

No of eye medications administered via SPL by owner	Drugs administered via the SPL	Maximum number of eye drops given by owner per day	Treatment outcome	Tolerant of eye drops by end of treatment	Number of days between removal of SPL and closure of owner questionnaire	Complications
3	Chloramphenicol, tacrolimus, hyaluronate-based lubricant	8	Good	Yes	870	Tube slippage
3	Ofloxacin, serum, hyaluronate based lubricant	8	Good	Yes	801	Butterfly tab replacement
2	Ofloxacin, serum	8	Good	Yes	678	None
2	Ofloxacin, serum	8	Conjunctival bridge graft placed following CCT dehiscence but good visual outcome achieved	No	608	CCT dehiscence Butterfly tab replacement
0	Ciprofloxacin, hyaluronate-based lubricant	0	Good	Yes	n/a	None
1 2	Chloramphenicol, Chloramphenicol, serum	4	Good	No	580	Dermatitis at location of butterfly tabs
2	Chloramphenicol, serum	8	Good	Yes	435	None
1	Chloramphenicol, hyaluronate-based lubricant	4	Good Celsus Hotz blepharoplasty performed at a later date	Yes	667	None
2	Chloramphenicol, hyaluronate-based lubricant	6	Good	Yes	76	Butterfly tab replacement
1	Prednisolone acetate	3	Good		204	None
3	Ofloxacin, serum, hyaluronate-based lubricant	16	Good	Yes	5	Tube repair
1	Chloramphenicol	4	Good	Yes	6	None

However, a statistically significant difference was not found when responses were compared with using the SPL system (*p*-value 0.5).

A statistically significant difference was identified between the mean number of people required to administer eye drops directly onto the eye compared with via the SPL (2.25 people (range 2–3) and 1.4 (range 1–2)) respectively (*p*-value 0.023).

Three owners (27.2%) reported the experienced affected the bond with their dog in the short term.

When asked to assign a score (0 =not confident to 100 = very confident) to indicate how owners felt using the SPL system after receiving a demonstration by a veterinary surgeon or nurse, a mean score of 88.7 (range 70–100) was recorded.

All owners (11/11) answered the application of drops through the SPL was easier compared with applying the eye drops onto their dog's eye at the time of placement.

Several participants commented on the ease of applying drops and reduction in the stress when using the SPL (Table 4). Owners disliked the appearance of the SPL and some felt the tubing appeared flimsy and easy to damage. Several owners reported a reaction to the eye drop passing through the tubing and objected to their dog wearing a harness and protective plastic cone at all times while the SPL was in place.

Most participants (8/11, 72.7%) had received advice regarding positive reinforcement following application of eye drops, but very few (3/11, 27.2%) recalled having a discussion about referral to a behavioral specialist.

TABLE 3 Summary of owner responses from the questionnaire.

	Drops directly onto the eye		Using the SPL			
	Response					
Question	**Yes**	**No**	**Yes**	**No**	**Statistical test**	***p*-Value**
Did your dog ever behave in a way that prevented you from putting drops into the eyes?	11	0	0	11	McNemar	<.01*
Were you able to apply the drops into the eye for the recommended number of times a day?	0	11	10	1	McNemar	<.01*
Did you ever feel concerned you might accidentally injure your dog's eye while applying the eye drops?	4	7	10	1	McNemar	.031*
Did you ever feel concerned that your dog might hurt themselves when you were applying drops into their eye?	5	6	10	1	McNemar	.219
Did you ever feel concerned that your dog might hurt you when you were applying drops into their eye?	8	3	11	0	McNemar	.5

	Drops directly onto the eye		Using the SPL			
Question	**Average assigned score (0–100)**	**Range**	**Average assigned score (0–100)**	**Range**	**Statistical test**	***p*-Value**
How easy did you find applying drops into your dog's eye	86.82	50–100	24.45	(0–87)	Wilcoxon signed rank test	.004*
How confident would you feel if you were asked to apply drops directly onto your dog's eyes again?	57.63	0–100				
How confident did you feel applying the drops through the SPL system after it was demonstrated to you?	88.73	82–100				

TABLE 4 Summary of the comments from owners submitted in the questionnaire

Summary of Comments	**Number of owners**
Positives	
Less stressful to apply the drops to the eye through the SPL	2
Easier to apply the medication	4
Effective at delivering medication	1
Able to distract the dog during application of drops with food	2
Shortened recovery time	1
Negatives	
Disliked the appearance of the SPL	3
The procedure required to place the SPL	1
Dog seemed distressed by the administration of drops	3
Wearing a harness	2
Wearing a cone	1
Risk of damage to the SPL tubing	3

At the time the questionnaire was submitted to owners, all dogs were still alive. Eight dogs (66.7%) required ongoing topical medication, for conditions such as keratoconjunctivitis sicca, and all were able to receive topical medication applied directly.

4 | DISCUSSION

This retrospective study is the first review of subpalpebral lavage use in dogs for remote administration of topical eye medication. The use of a subpalpebral lavage has been widely reported in horses[12–15] and is considered a safe and efficient method of remote eyedrop delivery for both vets and owners. SPL placement in dogs for management of corneal ulceration is described in a single report[18] and a case series of four patients.[19] However, a case series including assessment of owner compliance using the SPL has not previously been described.

4.1 | Site and method of SPL placement

Subpalpebral lavage placement was performed exclusively in the ventromedial eyelid in this study, but ventrolateral and dorsal placement has been reported for dogs,[19] horses,[14,15] a llama, a harbor seal[17] and humans.[16]

Comparison between studies reporting the complications with SPL placement in a population of horses with SPLs[12,15] indicates both sites are associated with an acceptable rate and severity of complications.[13] However, a prospective, randomized trial comparing complication rates in upper and lower SPLs is required to draw any firm conclusions. In this study, placement of the SPL in the ventromedial lid was chosen over dorsal or ventrolateral sites as it was felt the third eyelid would protect the cornea from mechanical trauma from movement of the footplate.

Subpalpebral lavages were secured using butterfly tabs secured onto the skin with suture material, as described for placement in horses.[12] A previous study[19] utilized two techniques for SPL placement in four dogs; a fingertrap technique in two cases and subdermal tunneling of the tubing in the remaining patients. There were no major complications reported, but a temporary tarsorrhaphy was placed when using the finger trap technique due to concerns regarding movement of the footplate.

4.2 | Complications

Minor complications occurred in 6/15 eyes (40.0%) which were limited to problems with the tubing and securing the SPL onto the face. Dermatitis of the skin at the site of placement was also reported in one dog but was mild and resolved following device removal. One major complication occurred in one eye due to a corneo-conjunctival graft dehiscence that required a revision surgery, but this was considered unrelated to the SPL. The SPL was well tolerated by all patients in this study but they learned to anticipate arrival of medication as it passed through the tubing. They were unable to behave in such a way to prevent its administration, but the process did cause some mild resentment, particularly to the air bolus that followed medication use.

Rushton et al. did not describe any major complications using the dorso and ventrolaterally placed SPLs in dogs using the fingertrap and subdermal tunneling methods. However, details regarding minor complications were not discussed. The incidence of complications in horses varies between studies. Minor complications, such as eyelid swelling, butterfly tab replacement, and tearing of the SPL tubing, ranged between 13 and 38%.[12,14,15] Major complications, such as iatrogenic corneal ulceration and eyelid infection, occurred in 0%–24% of patients.[12,14,15]

4.3 | Compliance

Drug compliance in the context of veterinary medicine has been defined as the extent to which owners adhere to instructions when administering prescribed drugs to their animals.[20] This can be considered in terms of the percentage of prescribed doses actually administered, the percentage of days on which the correct number of doses were given or were administered on time.[21]

Poor compliance plays a major role in outcome and treatment failure[1] and in human health care, is expected in 30%–50% irrespective of disease, prognosis or setting.[22] Non-compliance with daily eye drops may lead to poor disease control and progressive visual loss.[23–25] The magnitude of the ocular morbidity associated with mediation non-compliance in human glaucoma has been widely investigated. Glaucoma is the leading cause of blindness worldwide and requires lifelong treatment to reduce negative outcomes including pain and vision loss. An estimated 10% of glaucomatous vision loss is due to poor compliance[2] and an association demonstrated between visual field deficits severity and poor medication compliance.[26]

There are several studies examining the occurrence of poor compliance with oral antimicrobial treatments[20,21,27–30] and topical aural medication[31] in dogs, but there are no publications studying the incidence and effect of poor compliance using topical eye medication in veterinary species.

Most patients in this study were treated for ulcerative keratitis and received topical antibiotic treatment.

Antimicrobial resistance (AMR) has been identified as a major global public health threat by the World Health Organization. Poor compliance with antibiotic treatment can lead to inadequate therapy response, increased risk of recurrent infection and has been identified as a theme in the emergence of AMR.[32,33] Clinicians may become doubtful of a drug's effect if the response to treatment does not meet expectations and consequently prescribe a different drug that may have an inappropriate spectrum or is not considered a first-line antibiotic medication.[34] The improved compliance when using the SPL system reported in this study may have the added benefit of helping to reduce the risk of AMR in these challenging cases.

One of the main reasons for poor ophthalmic medicine compliance in humans is due to poor administration technique.[3] Correct opening and successful squeezing of eye-drop containers can present a manual problem for elderly people, even when they are free of conditions hindering self-application.[4,5] Although not encountered in the current study, owners with physical disabilities that prevent eye drop administration are another potential scenario where SPL placement could be considered.

Constant rate delivery of ophthalmic medications using a continuous infusion pump (Infu-Disc Medical-e-Cell) has previously been described as an effective method of drug delivery in horses.[35] A pediatric syringe driver was utilized in one case that required a continuous supply of topical lubricating drops due to neurogenic keratoconjunctivitis. This proved successful in supplying artificial tear replacement while the patient remained hospitalized until the lacrimal innervation and tear production had sufficiently recovered. This demonstrates potential for use of constant rate delivery devices in canine patients requiring intensive medication or for owners unable to administer eye drops due to physical or time limitations.

4.4 | Behavior escalation

Problematic behavior, such as a flight response and aggression, preventing administration of drops was the sole reason for placement of the SPL in all cases in this study.

An association between certain behavioral problems, such as aggression, and musculoskeletal pain has previously been described.[36,37] Studies that specifically assess the effect of ocular pain on behavior in canine patients are lacking. Discomfort associated with application of drops onto a painful eye, or the anticipation of experiencing pain, are potential stressors that could result in the patient exhibiting problematic behavior.

Problematic behavior is commonly exhibited as a manifestation of pain, but also as an exacerbation of existing behavioral issue. An adjunctive behavior (behavior reliably exhibited in response to an unrelated stimulus) associated with pain may underpin the emergence of undesirable behavioral traits in these patients.[38] All cases that required ongoing topical treatment were trained to accept direct application of drops, so it is likely that once the source and memory of discomfort were removed, an improvement in the problematic behavior occurred. Referral to a behavioral specialist was not commonly discussed with the owners of the patients in this study but should be explored in cases that do not respond to simple training, such as positive reinforcement, once the eye has recovered, or if the owners report pre-existing behavioral problems.

4.5 | Owner experience and effect on the bond with their dog

Problematic behavior can be a cause of significant distress for an owner and may ultimately result in a failure of the human–dog relationship.[39–41] Aggression is one of the most common reasons for the referral of dogs to behavior specialists[42–44] and for dogs to be surrendered to rescue shelters.[45] There were few reports of patient aggression directed toward the owners, and most participants did not report a damaging effect on their relationship with their dog in this study.

4.6 | Limitations

There were a small number of participants in this study that was limited by the number of dogs that underwent placement of an SPL. This group was further reduced as one dog was discharged following removal of the SPL as it was no longer required. However, all 11 clients that were asked to participate completed the survey.

Discrepancies between subjective self-evaluation and objective measurement of compliance is well reported. In prospective studies, this is overcome using a Medication Event Monitoring System (MEMS) to electronically monitor drug compliance. MEMS devices have been used in veterinary studies[21,27] to assess client compliance with the administration of oral antibiotic treatment but are large, expensive, and difficult to use. This would not have been practical due to the retrospective nature of this study; most cases had been prescribed topical medication prior to referral. However, the discrepancy in owner self-reported compliance is likely to be consistent pre- and post-SPL placement.

There was a wide range in the time between owners completing the survey and the removal of the SPL system that could have affected the owner's memory of their experience. All dogs in the study had an excellent treatment

outcome, so it is possible an owner's recollection could become more favorable as time passed since the SPL system was removed. This may have particular significance when reporting the effect on their relationship with their dog prior to and during the SPL placement period as it is likely that owners were able to repair any short-term damage to their relationship in this time.

The questionnaire did not explore the owner's experience and confidence regarding application of drops before referral and placement of the SPL. Eye drop compliance and the owner's experience of topical medication are important areas in the treatment of ophthalmic diseases that are overall lacking in research.

5 | CONCLUSION

Subpalpebral lavage placement provides a practical and safe solution for the provision of frequent multimodal ocular medication when treating patients with challenging behavior. Improvements in compliance, ease of medication administration, and risk of iatrogenic trauma to the eye were reported by owners using the SPL system. Patients intolerant of topical eye drops can be trained to accept eye drops while the SPL system is in place to enable provision of long-term medication if required.

CONFLICT OF INTEREST

None of the authors of this article have a financial or personal relationship with other people or organizations that could inappropriately influence or bias the contents of this paper. The results of this paper have been presented at the Annual Scientific Meeting of the European College of Veterinary Ophthalmologists in 2021.

ORCID

Josie Parker https://orcid.org/0000-0002-4983-5768

REFERENCES

1. Vermeire E, Hearnshaw H, Van Royen P, Denekens J. Patient adherence to treatment: three decades of research. A comprehensive review. *J Clin Pharm Ther*. 2001;26(5):331-342. doi:10.1046/j.1365-2710.2001.00363.x
2. Taylor SA, Galbraith SM, Mills RP. Causes of non-compliance with drug regimens in glaucoma patients: a qualitative study. *J Ocul Pharmacol Ther*. 2002;18(5):401-409. doi:10.1089/10807680260362687
3. Hennessy AL, Katz J, Covert D, et al. A video study of drop instillation in both glaucoma and retina patients with visual impairment. *Am J Ophthalmol*. 2011;152(6):982-988. doi:10.1016/j.ajo.2011.05.015
4. Dietlein TS, Jordan JF, Luke C, Schild A, Dinslage S, Krieglstein GK. Self-application of single-use eyedrop containers in an elderly population: comparisons with standard eyedrop bottle and with younger patients. *Acta Ophthalmol*. 2008;86(8):856-859.
5. Matossian C. Noncompliance with prescribed eyedrop regimens among patients undergoing cataract surgery-prevalence, consequences, and solutions. *US Ophthalmic Rev*. 2020;13(1):18-22. doi:10.17925/USOR.2020.13.1.18
6. Ozdemir S, Wu HK, Finkelstein EA, Wong T. Parents' views on their children's use of eye drops and willingness to accept a new sustained-release subconjunctival injection. *Clin Ophthalmol*. 2017;11:1903-1909. doi:10.2147/OPTH.S141851
7. Baum J, Barza M. Topical vs subconjunctival treatment of bacterial corneal ulcers. *Ophthalmology*. 1983;90(2):162-168. doi:10.1016/s0161-6420(83)34583-8
8. Blizzard C, Desai A, Driscoll A. Pharmacokinetic studies of sustained-release depot of dexamethasone in beagle dogs. *J Ocul Pharmacol Ther*. 2016;32(9):595-600. doi:10.1089/jop.2016.0025
9. Acton AE, Beale AB, Gilger BC, Stoskopf MK. Sustained release cyclosporine therapy for bilateral keratoconjunctivitis sicca in a red wolf (*Canis rufus*). *J Zoo Wildl Med*. 2006;37(4):562-564. doi:10.1638/06-021.1
10. Semenkow SL, Johnson NM, Maggs DJ, Margulies BJ. Controlled release delivery of penciclovir via a silicone (MED-4750) polymer: kinetics of drug delivery and efficacy in preventing primary feline herpesvirus infection in culture. *Virol J*. 2014;11:34. doi:10.1186/1743-422X-11-34
11. Driscoll A, Blizzard C. Toxicity and pharmacokinetics of sustained-release dexamethasone in beagle dogs. *Adv Ther*. 2016;33(1):58-67. doi:10.1007/s12325-015-0280-7
12. Giuliano EA, Maggs DJ, Moore CP, Boland LA, Champagne ES, Galle LE. Inferomedial placement of a single-entry subpalpebral lavage tube for treatment of equine eye disease. *Vet Ophthalmol*. 2000;3(2–3):153-156. doi:10.1046/j.1463-5224.2000.3230153.x
13. Carslake HB. Should I place a subpalpebral lavage system in the upper or lower eyelid? *Equine Vet Educ*. 2019;31(6):335-336. doi:10.1111/eve.12879
14. Cornelissen S, Finding E, Bowen IM, Bullard C, Hallowell GD. Factors affecting complication rates with subpalpebral lavage catheter use in horses abstracts. *Equine Vet J*. 2015;47:21. doi:10.1111/evj.12486_48
15. Sweeney CR, Russell GE. Complications associated with use of a one-hole subpalpebral lavage system in horses: 150 cases (1977-1996). *J Am Vet Med Assoc*. 1997;211(10):1271-1274.
16. Meallet MA. Subpalpebral lavage antibiotic treatment for severe infectious scleritis and keratitis. *Cornea*. 2006;25(2):159-163. doi:10.1097/01.ico.0000177837.31249.19
17. Borkowski R, Moore PA, Mumford S, Carastro S. Adaptations of subpalpebral lavage systems used for llamas (Lama glama) and a Harbor Seal (Phoca vitulina). *J Zoo Wildl Med*. 2007;38(3):453-459.
18. Woodham-Davies S. Nursing patients with a corneal graft and the use of a subpalpebral lavage system. *Vet Nurs J*. 2018;33(9):266-268. doi:10.1080/17415349.2018.1490678
19. Rushton JO. Using subpalpebral lavage systems to deliver ocular drugs to 4 fractious dogs. *Companion Anim*. 2021;26(2):1-5. doi:10.12968/coan.2020.0062
20. Grave K, Tanem H. Compliance with short-term oral antibacterial drug treatment in dogs. *J Small Anim Pract*. 1999;40(4):158-162.
21. Adams VJ, Campbell JR, Waldner CL, Dowling PM, Shmon CL. Evaluation of client compliance with short-term administration of antimicrobials to dogs. *J Am Vet Med Assoc*. 2005;226(4):567-574.
22. Morris LS, Schulz RM. Patient compliance–an overview. *J Clin Pharm Ther*. 1992;17(5):283-295.

23. The advanced glaucoma intervention study (AGIS): 7. the relationship between control of intraocular pressure and visual field deterioration. *Am J Ophthalmol*. 2000;130(4):429-440. doi:10.1016/S0002-9394(00)00538-9
24. Kass MA, Heuer DK, Higginbotham EJ, et al. The ocular hypertension treatment study: a randomized trial determines that topical ocular hypotensive medication delays or prevents the onset of primary open-angle glaucoma. *Arch Ophthalmol*. 2002;120(6):701-713.
25. The effectiveness of intraocular pressure reduction in the treatment of normal-tension glaucoma. *Am J Ophthalmol*. 1998;126(4):498-505. doi:10.1016/S0002-9394(98)00272-4
26. Sleath B, Blalock S, Covert D, et al. The relationship between glaucoma medication adherence, eye drop technique, and visual field defect severity. *Ophthalmology*. 2011;118(12):2398-2402. doi:10.1016/j.ophtha.2011.05.013
27. Barter LS, Watson AD, Maddison JE. Owner compliance with short term antimicrobial medication in dogs. *Aust Vet J*. 1996;74(4):277-280.
28. Bomzon L. Short-term antimicrobial therapy-a pilot compliance study using ampicillin in dogs. *J Small Anim Pract*. 1978;19(1–12):697-700. doi:10.1111/j.1748-5827.1978.tb05559.x
29. Maille V, Hoffmann J. Compliance with veterinary prescriptions: the role of physical and social risk revisited. *J Bus Res*. 2013;66(1):141-144. doi:10.1016/j.jbusres.2012.09.006
30. Van Vlaenderen I, Nautrup BP, Gasper SM. Estimation of the clinical and economic consequences of non-compliance with antimicrobial treatment of canine skin infections. *Prev Vet Med*. 2011;99(2):201-210. doi:10.1016/j.prevetmed.2011.01.006
31. Boda C, Liege P, Reme CA. Evaluation of owner compliance with topical treatment of acute otitis externa in dogs: a comparative study of two auricular formulations. *J Small Anim Pract*. 2011;9(2):157-165.
32. Pechère J-C, Hughes D, Kardas P, Cornaglia G. Non-compliance with antibiotic therapy for acute community infections: a global survey. *Int J Antimicrob Agents*. 2007;29(3):245-253. doi:10.1016/j.ijantimicag.2006.09.026
33. Moradi M, Hamedi-Shahraki S, Rezayee M, Verdi M. Compliance with antimicrobial therapy: evaluating the related factors. *J Pharm Care*. 2013;1(2):60-64.
34. Maddison JE. Medication compliance in small animal practice. *Ir Vet J*. 2011;64(1):39-43.
35. Myrna KE, Herring IP. Constant rate infusion for topical ocular delivery in horses: a pilot study. *Vet Ophthalmol*. 2006;9(1):1-5.
36. Camps T, Amat M, Mariotti VM, Le Brech S, Manteca X. Pain-related aggression in dogs: 12 clinical cases. *J Vet Behav*. 2012;7(2):99-102. doi:10.1016/j.jveb.2011.08.002
37. Barcelos AM, Mills DS, Zulch H. Clinical indicators of occult musculoskeletal pain in aggressive dogs. *Vet Rec*. 2015;176(18):465. doi:10.1136/vr.102823
38. Mills DS, Demontigny-Bédard I, Gruen M, et al. Pain and problem behavior in cats and dogs. *Animals*. 2020;10(2):318. doi:10.3390/ani10020318
39. Elyssa P, Pauleen CB, Paul DM. Current perspectives on attachment and bonding in the dog–human dyad. *Psychol Res Behav Manag*. 2015;8:71-79. doi:10.2147/PRBM.S74972
40. Beerda B, Schilder MBH, van Hooff JARAM, de Vries HW. Manifestations of chronic and acute stress in dogs. *Appl Anim Behav Sci*. 1997;52(3):307-319. doi:10.1016/S0168-1591(96)01131-8
41. Salman MD, New JJG, Scarlett JM, Kass PH, Ruch-Gallie R, Hetts S. Human and animal factors related to relinquishment of dogs and cats in 12 selected animal shelters in the United States. *J Appl Anim Welf Sci*. 1998;1(3):207-226.
42. Blackshaw JK. Abnormal behaviour in dogs. *Aust Vet J*. 1988;65(12):393-394.
43. Beaver BV. Owner complaints about canine behavior. *J Am Vet Med Assoc*. 1994;204(12):1953-1955.
44. Stafford KJ. Opinions of veterinarians regarding aggression in different breeds of dogs. *N Z Vet J*. 1996;44(4):138-141.
45. Christensen EL, Scarlett J, Campagna M, Houpt KA. Aggressive behavior in adopted dogs that passed a temperament test. *Appl Anim Behav Sci*. 2007;106(1–3):85-95. doi:10.1016/j.applanim.2006.07.002

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

How to cite this article: Parker J, Ioannides J, Kumaratunga V, Preston J, Hartley C, Donaldson D. Subpalpebral lavage placement for remote topical administration of ocular medications in 12 dogs: A retrospective review and assessment of owner perception. *Vet Ophthalmol*. 2023;26:108-120. doi: 10.1111/vop.13029