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Surgical Versus non Surgical Techniques for Punctal Occlusion as Alternative Methods for Treatment of Dry-eye in Dogs

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ABSTRACT

The aim of the study was to describe three alternative methods for treatment of dry-eye in dogs and to determine the most appropriate method for clinical application. These treatments were include, surgical punctal occlusion and non-surgical temporary occlusion using silicon plugs and butyl-cyanoacrylate adhesive solution. It was carried out in two stages, stage I: to evaluate the efficacy of the three techniques in 12 normal dogs, which allocated into three equal groups as follows, silicon plugs (G1), butyl-cyanoacrlate adhesive (G2) and surgical punctal occlusion (G3). Stage II: a clinical study in nine clinical cases affected with dry-eye. The upper and lower puncta were obstructed, and Schirmer tear test I (STTI) values and Jones test were performed before and after carrying out the occlusion technique. Each technique was evaluated twice weekly for 60 days (stage I) and 30 days (stage II). All techniques improved the results of STTI values comparing to their control groups, with persistency period 20-23 days (G1), 12-16 days (G2) and 60 days (G3). The study proved that surgical occlusion was highly successful as permanent method with minimal complications and would be the treatment of choice for unresponsive cases to medical treatment of dry-eye in dogs.

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Introduction

Dry-eye, or keratoconjunctivitis sicca (KCS), is a relatively common ocular condition in dogs, characterized by dry ocular surface with corneal and conjunctival inflammation, which resulted from a deficiency of tear production (Sansom and Barnett, 1985; Rosa *et al.,* 2012; Giuliano, 2013; Best *et al.,* 2014; Dodi, 2015). Tear film provides avascular cornea with oxygen and nutrients, protective antibodies, antimicrobial proteins and removes surface debris and infectious agents (Sanchez, 2007; Giuliano, 2013). Hence, lack of tear production can predispose to corneal dryness and secondary bacterial conjunctivitis (Maggs *et al*., 2013; Best *et al.,* 2014).

The most common cause of KCS is immune-mediated inflammation of the lacrimal glands (Williams*,* 2008; Dodi, 2015), there are also, other several causes, which include, congenital abnormalities (Westermeyer *et al*., 2009; Hartley al., 2012), infectious diseases, as canine distemper (de Almeida *et al*., 2009), or leishmania (Ciaramella *et al*., 1997), metabolic disorders (Williams *et al.,* 2007), neurogenic, damage to parasympathetic innervations (Matheis al., 2012), some drugs such as, sulfonamide antibiotics (Collins *et al.,* 1986) and etodolac (Klauss *et al.,* 2007), iatrogenic, i.e., as a result of other ocular diseases (Helper al., 1996) and idiopathic (Matheis *et al.,* 2012). In early stages, the animals manifest the following clinical signs, conjunctival hyperemia, and thick, sticky yellow to greenish discharge that covering the cornea and accumulating in the conjunctival sac and periocular tissue, whereas, in severe cases, corneal opacity, pigmentation and/or corneal ulcer scan be also developed (Sansom and Barnett, 1985; Sanchez, 2007; Giuliano, 2013).

There are several treatments of canine dry eye include medical therapy (topical medications), surgical treatment and temporary punctal occlusion. Although these approaches are technically different, they aimed essentially to provide constant lubrication and conservation of existing tear (Liu and Sadhan, 2002).

Topical medications including, artificial tear solutions, gels, ointments and tear production stimulants is not often a helpful treatment of dry-eye in dogs, as the application of these medications to the eye is challenging in affected dogs and treatments will be required for the life of the animal (Best *et al.,* 2014). In addition, unresponsive cases to pharmacological treatment have a poor prognosis, as they can develop chronic

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keratitis, which lead to permanent corneal fibrosis, ulceration, pigmentation and consequently, can lead to vision loss (Sansom and Barnett, 1985). For these unresponsive cases, alternative treatments are considered, such as, parotid duct transposition (PDT) (Rhodes *et al*., 2012); labial salivary gland autograft (Castanho *et al*., 2013) and non surgical (temporary) punctal occlusion using silicon plugs (Williams, 2002; Gelatt *et al*., 2006) or other adhesives (Rosa *et al.,* 2012; Honsho *et al*., 2014).

Parotid duct transposition (PDT) is successful in treatment of dry eye; however, it has a high complication rate (Rhodes *et al*., 2012). Although labial salivary gland autograft has less complication comparing to PDT (Castanho *et al*., 2013), it still has the disadvantage of using saliva as a substitute for the corneal tear film, which could not provide sufficient nutrition, permits secondary bacterial infection and has adverse effects on eye surface (Giuliano, 2013). In contrast, using and handling of the adhesives for punctal occlusion have been proved to be simple and effective with limited complications (Williams, 2002; Gelatt *et al*., 2006; Cardoso *et al*., 2013; Honsho *et al*., 2014). Additionally, the occlusion of the lower lacrimal punctum (Williams, 2002) or the upper and lower puncta (Gelatt *et al*., 2006) limits tear drainage, provides good distribution of the pericorneal tear film on the ocular surface, and prolongs lubrication (Honsho *et al*., 2014), which resulting in significant clinical improvement even without increased tear production (Williams, 2002).

The aim of the present study was to evaluate the efficacy of the surgical obstruction of the lacrimal puncta versus the non surgical occlusion using silicone plugs and Butyl-cyanoacrylate adhesive solution, with the hypothesis that, the most effective method would provide longer persistency of punctal occlusion with minimal complications.

Materials and methods

Study design

The study was carried out in two stages as follows: Stage I, twelve normal, native (balady) dogs, 5 males, 6 females, aged between one to three years and weighted 16-20 Kg were purchased to be used in this phase. These dogs were subjected to punctal occlusion and evaluated for sixty days.These animals were allocated into three equal groups.The punctal occlusion was performed using silicon plugs (group 1, G1), Butyl-cyanoacrylate adhesive solution (group 2, G2) and surgical method (group 3, G3). Before and after the procedure, the dogs were examined using indirect ophthalmoscopy, Jones test,Schirmer tear test I (STTI) and II (STTII). All dogs underwent the first stage of the study haven’t any ocular abnormalities, with normal STTI and STTII values and positive to Jones test. Any ophthalmic or punctal abnormalities were considered exclusion criteria.

The second stage of this study was carried out on nine dogs suffering dry eye. These nine cases are 5 males and 4 females, aged between 8 months to two years and weighted 18-32 Kg; they were attended to private clinics with yellowish–greenish exudates accumulated in the conjunctival sac and ocular hyperemia. To confirm diagnosis of dry-eye, STT tests were performed and the obtained values were between 3 and 5 mm/minute. They were treated using the appropriate technique of punctal occlusion that was described in the first stage. The animals were evaluated for thirty days after treatment.

All the study procedures and the use of animals were complied with protocols approved by the institutional animal care committee and adhered to the Egyptian legal requirements.

Stage I (n=12)

Application of STTI and Jones test were done for each dog before and after carrying out the occlusion technique of the puncta lacrimalis. The Jones is used for evaluation the patency of the nasolacrimal drainage system. To achieve that, flourescein impregnated paper strips were used. Strips (Optitech eye care Tarun enterprises, India) were moistened before applications by one or two drops of sterile saline solution, then touched the lower conjunctival fornix with moistened tip. The nostrils were monitored for the appearance of fluorescein. The results were considered negative (occluded puncta), when the dye did not appear at nasal opening within 30 to 45 minutes after application, however considered positive (patent puncta) if the dye appeared at the nostriles.

STTI was carried out using a standard i.e., maximum reading 35 mm. Sterile STT Strips (Optitech eye care Tarun enterprises, India), were placed in the lateral aspect of the lower fornix for 1 min. Data was measured immediately and recorded in mm/min, by the same observer.

The animals were fasted 8 hours before anaesthesia. They were premedicated using 2 mg/kg of xylazine hydrochloride i/m (Xyla-Ject®, ADWIA CO. S.A.E. Egypt). The animals received 10 mg/kg of ketamine hydrochloride i/m (Narketan 10, Vetoquinol. Co, UK) for general anesthesia. Six out twelve dogs received half the dose of ketamine hydrochloride at the 60th minute after starting the procedure for continuation of anesthesia.

The animals were in lateral recumbence, the head restrained with an assistant and the left eye was prepared antiseptically using Desomedine® 0.1% eye antiseptic solution (BAUSH & LOMB incorporated Greenville, U.S.A), whereas the right eye served as control. The upper and lower conjunctival fornices were gently dried using a sterile swab. The location of the upper and lower puncta (Fig. 1) was identified visually by the aid of loop headband magnifier (Fig. 2) with detachable light source (MG 81001-B, China), thereafter; the treatment method was performed as following:

Fig. 1. Location of upper and lower puncta (black arrows) in dog eye, notice the less pigmented skin around the site of the punctal orifices, (M) medial canthus, (L) lateral canthus.

Silicone Plug Punctal Occlusion

In group 1 (G1, n=4), silicon plugs (medical grade silicone plug, 24 plugs per box, FCI ophthalmics, U.S.A) 0.8 mm in diameter and 2 mm in length was inserted into the upper and lower puncta (Figs. 3 a,b), with the aid of illumination and magnification provided by the head-loop. Each plug has a slightly rounded head and a rod like shaft. To insure that the plug was inserted correctly, the mucous membrane that cover the head of the plug should be seen projected externally, indicating successful punctum closure.

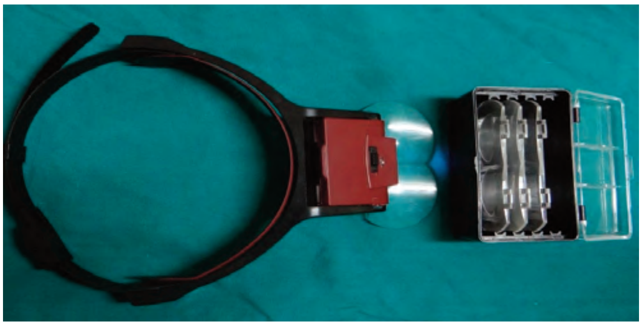

Fig. 2. loop headband magnifier with detachable light source.

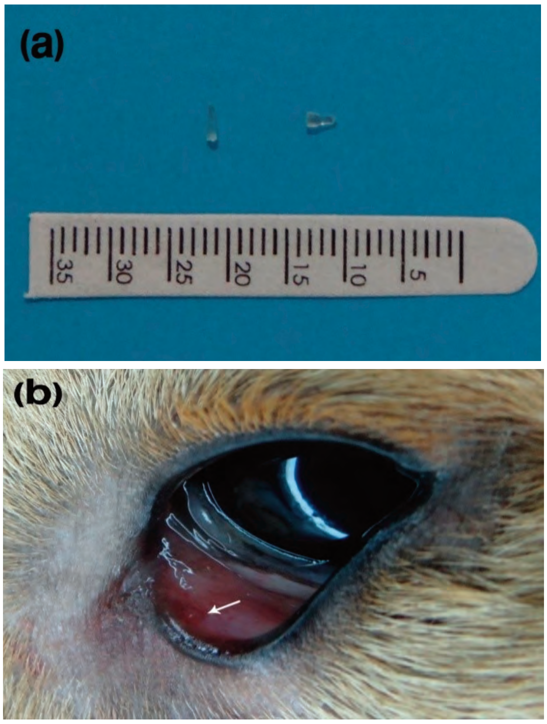

Fig. 3. (a) Silicon plugs. (b) Inserted silicon plug into lower punctum, notice, pulged mucous membrane indicating succssful insertion.

Butyl-cyanoacrylate Punctal Occlusion

In group 2 (G2, n=4), 0.3 ml of butyl-cyanoacrylate solution (HOPSON®, medical glue 0.5ml/ampule, Ningbo, Hopson, China) was injected into the lower and upper puncta, using sterile 22-24 gauge intravenous catheter (without metal stylet) (Figs. 4 a,b). First, the catheter introduced slowly into the puncta until it felt to probe the lacrimal caniliculi, the catheter stopped when 1-2 mm of its shaft was successfully inserted, then, 0.3 ml adhesive solution was injected and the catheter was slowly removed. Successful obstruction was indicated when the hardened adhesive was seen occluding the puncta. If there was an extra-solution oozed during the procedure, the operator waited until it hardened and then could be easily removed by a sterile cotton swab.

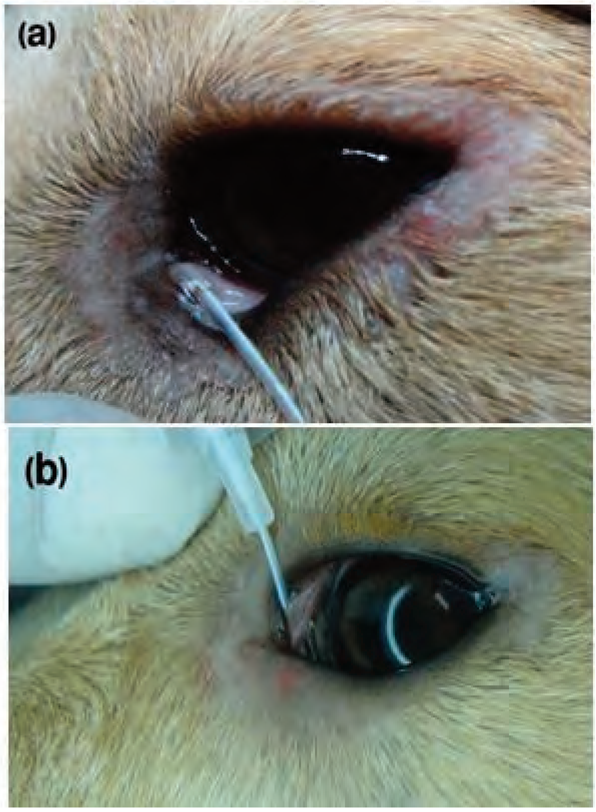

Fig.4. Injection of adhesive solution into the lower (a) and the upper (b) punctum.

Table 1. Statistical data of stage I: STTI values and result of Jones test.

Item	Group 1 (n=4) *Silicon plug method*		Group 2 (n=4) *Butyl-cyanoacrylate method*		Group 3 (n=4) *Surgical method*	
	Left-eye	Right - eye Control	Left-eye	Right - eye Control	Left-eye	Right - eye Control
Duration *	23 day		16 day		60 day	
STT I values	19.56± 1.46^{a}	17.94 ± 0.60^{b}	20.31 ± 0.94^{a}	17.19± 1.75^{b}	20.13 ±0.88^{a}	17.86± 1.65^{b}
Minimum	17 mm/min	17 mm/min	19 mm/min	16 mm/min	19 mm/min	16 mm/min
Maximum	22 mm/min	19 mm/min	22 mm/min	18 mm/min	22 mm/min	18 mm/min
Jones test	Negative for-20-23 day	–	Negative for 12-16 day	–	Negative for 60 day	–

Data expressed as Mean ± SD
*:(according to maximum persistency of punctal occlusion in each technique)
Values with different letter within the same row differed significantly at least at P< 0.05.

Surgical method

In group 3 (G3, n=4), the surgical procedure was carried out using a surgical burr (Fig. 5) of 0.8 mm in diameter to remove the epithelium, which line the punctum and the underlying lacrimal canaliculi. Subsequently, the stripped surfaces were sutured together and parallel to the eyelid margin with a simple interrupted suture pattern using 5/0 polyglycolic acid (PGA) with 18 mm, ½ circle needle (EGYSORB®, TAISIER-MED, Egypt).

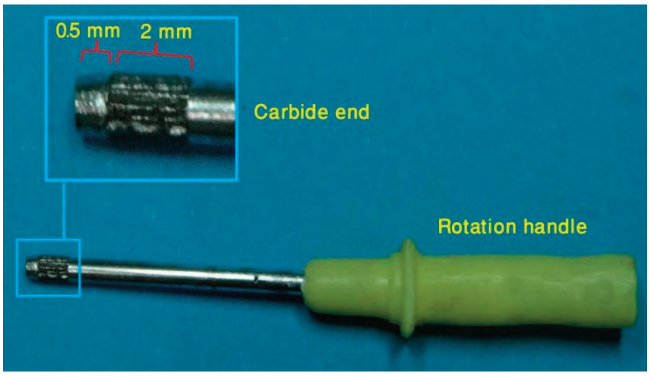

Fig.5. Surgical burr of 0.8 mm in diameter.

Surgical occlusion was performed as the following: The lower punctum was probed using a flexible catheter to facilitate entrance of surgical burr (Fig. 6a). The surgical Burr was introduced into a depth of 2 mm of the lacrimal canaliculi and gently rotated (Fig. 6b), for removal of lining epithelium that indicated by oozing of blood and appearance of reddish underlying layers (Fig. 6c). The striped edges were coappetated together and sutured using simple interrupted suture, parallel to eyelid margin (Fig. 6d).The same previously described procedures were repeated for the closure of upper punctum (Fig. 6 e,f,g).

At the end of this stage, left eyes were evaluated using Jones test and STTI, two times per week, for 60 days, whereas the STTI values were measured in right eyes as a control. In addition, the post-operative complications were noticed and recorded. Data of each animal group was recorded and statistically analyzed, in order to evaluate the efficacy of each treatment method. Consequently, the most effective method required for stage II in this study (clinical cases) was determined.

Stage II (n=9)

Dry-eye was diagnosed in nine dogs using, clinical signs, STTI and fluorescent stain as described in Table 2. These nine cases underwent stage II of this study, and used to apply the selected method (The surgical method described in stage I). Prior to surgical interference, these dogs recieved the following topical medications: Systane Ultra® (lubricant eye drops 10 ml solution, Alcon Cusl, S.A c/Camil Fabra, Barcelona, Spain), Olopatadine® 1 mg (Olohistine 5 ml ophthalmic solution, E.I.P.I.CO.), and Isoptomaxitrol® (antibiotic suspention, Alcon laboratories, Alcon a Novartis company, USA); 6 times daily, two drops in each conjunctival sac and for three successive days. For the first three days after surgery, Polystectran®(antibiotic drops, Alcon laboratories, Alcon a Novartis company, USA), 2 drops for each eye were used topically in the conjunctival sac 4 times daily.

Then the surgical method was evaluated again in these nine cases using the same ophthalmic tests described before (Jones test and STTI). Data recorded just after the procedure and twice weekly for 30 days.

Fig. 6. Procedures of surgical punctal occlusion in group 3, subsequently represented from (a) to (h): probing the lower punctum (a), using surgical burr to remove the epithelium (b), lower punctum after stripping its lining epithelium (c), closure using simple interrupted suture (d), probing the upper punctum (e), removal of epithelium of upper punctum (f) suturing the stripped upper punctum (g) left dog eye following procedure, notice the closure does not retract the eye lid margin inward or outward and there is no contact with corneal surface (h).

Statistical analysis

Data reported in stage I and II were evaluated for normality using the Shapiro-Wilk test, and the data were determined to be normally distributed and presented as mean ± SD. Data of stage I were statistically analyzed by one–way Analysis of variance (ANOVA) and Duncan's multiple range tests to determine significant difference between groups with statistical package for social sciences (SPSS) soft ware (version 17.0). A value of $P < 0.05$ was considered significant, as shown in Table 1.

Results

Stage I (n=12)

Silicone Plug Punctal Occlusion (G1, n=4)

All silicone plugs were easily and successfully inserted. All the dogs (G1, n=4), tolerate the procedure, no side effects were noticed. Post procedure evaluation using Jones test was negative indicated complete occlusion of both puncta for only 20-24 days. Results of STTI values in occluded eyes (19.56± 1.46) were significantly increased than those of control eyes (17.94 ± 0.60) at P< 0.05 as showen in Table 1, indicating improvement of amount of tears forming pericorneal tear film.

Butyl-cyanoacrylate Punctal Occlusion (G2, n=4)

In group 2, the catheterization of lower and upper puncta was easily and successful, as the catheter was introduced into depth of 1-2 mm of lacrimal canaliculi while applying gentle pressure, no bleeding or injury to mucous membrane was observed (Fig. 4 a,b). No solidification of adhesive solution inside the catheter was occurred during injection process. Oozing of adhesive solution was associated with injection of upper punctum more than the lower one, and polymerized particles were removed safely using cotton swab. 22 gauge catheters were used in 2 dogs, while 24 gauge catheters were used for the other 2 dogs. The results of Jones test showed the persistence of occlusion for 16 days in three dogs and 12 days in the remained one in this group. STTI values (20.31 ± 0.94) were significantly increased than those of control eyes (17.19± 1.75) at P< 0.05 as showen in Table 1, but no significant increase comparing to other methods used in stage I of study. All dogs were tolerated the procedure and no complications were recorded.

Surgical method (G3, n=4)

Surgical occlusion was performed as previously described (Figs 6 a-g). No entropion or ectropion were observed following surgery (Fig. 6h). Evaluation using STTI (Figs. 7 a,b) was indicated significant increase (20.13 ±0.88) comparing to the control group (17.86 ± 1.65) at P< 0.05, whereas, the results of Jones test revealing high persistence occlusion for 60 days as showen in Table 1. There was no significant increase in STTI values comparing to other groups. A few post operative complications were recorded include, slight local swelling, hyperemia around the sutured puncta. These observed complications disappeared at the end of the third day after surgery. Complete healing of the sutured puncta was observed at 12-16 days (Fig. 7c).

Stage II (n=9)

The analysis of the data described in stage I indicated that the surgical method was able to improve the results of STTI values with longer persistence time (Table 1). The surgical method was used as an alternative treatment in nine clinical cases of dry eye. These cases were not responded to several trails of medical treatments, and the main clinical signs were include, hyperemia, conjunctivitis, thick yellowish mucopurulent discharges (Figs 8 a,b) chemosis (Fig. 8b) and superficial keratitis (Figs 8c,d). After preoperative medications and surgery, the cases of 3 mm/min STTI values were slightly improved following surgery and showing higher readings from 6.42 ±0.53 to 8 ± 0.81 mm/min, whereas cases of 4-5 mm/min were increased to 7.28 ± 0.98 - 9.42 ± 0.53 mm/min (Table 2). Topical medications were administered for only the first three days after surgery, and there was no clinical need for continue medical treatment, as there was no recurrent clinical signs for 30 days of trial. Minor complications include local irritation at sutured sites were observed in two dogs, but after using neck collars the dogs become more calm. Local edema was noticed in 5 dogs and disappeared 48 hours following surgery. Clinical signs of dry eye were disappeared from 20 – 30 days postoperatively (Table 2).

Table 2. Stage II: Animals data, diagnosis and data after using surgical occlusions in 9 clinical cases.

Animals data					Diagnosis				Data after treatment	
Case number	Breed	Sex	Age (month)	Weight (Kg)	Eye Affected	Case history	Clinical signs	STT1	STT1 (Mean ± SD)	Time for signs recovery
1	Bulldog	♂	8	18	Bilateral	After a prolonged period of canine distemper treatment	Conjunctivitis, yellow purulent discharge.	4	7.7 ± 0.75	24
2	German shepherded	♀	16	23	Right	Old severe trauma of the upper eyelid during fighting	Chemosis, irritation manifested by blepharospasm, discharge.	3	8.0 ± 0.81	20
3	Golden Retriever	♀	14	21	Bilateral	Previous infection by canine distemper	Sticky white yellowish discharge and rubbing of the eye, mild corneal opacity.	5	7.7 ± 0.95	30
4	Rottweiler	♀	20	32	Bilateral	Idiopathic	Conjunctivitis, blepharospasm, sticky white yellow greenish discharge	5	9.42 ± 0.53	28
5	Greyhound	♀	10	23	Left	Idiopathic (with unhealthy tooth).	Dry red conjunctiva, loss of the luster of the cornea, sticky yellow discharge	4	8.14 ± 0.69	24
6	German shepherded	♂	18	24	Bilateral	Idiopathic (guarding together in bad hygienic conditions). Prolonged exposure to irritant foams in lead foundries.	Mucus and oily secretions on the corneal, conjunctival surfaces, sticky eyelids dullness of the cornea opacity and discomfort of the animal in light.	5	7.28 ± 0.95	30
7	German shepherded	♂	16	22	Bilateral			3	6.42 ±0.53	30
8	Doberman	♂	20	19	Bilateral	Prolonged use of sulfonamides and antibiotics (for treatment of severe Diarrhea), also there was remarkable loss of weight.	Sticky white yellowish discharge with crusts on the eyelids and rubbing of the eye, mild corneal opacity.	4	7.28 ± 0.98	28
9	Doberman	♂	24	24	Bilateral			3	6.5 ± 0.78	30

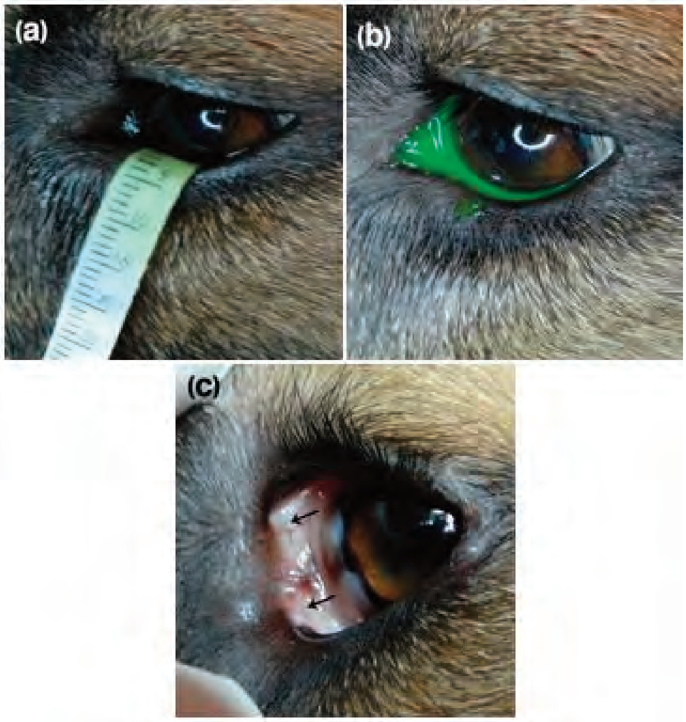

Fig. 7. Post-operative evaluation of eye in group 3, using STTI(a), Jones test (b) and showing complete healing of puncta (black arrows), at 16 days after surgical occlusion.

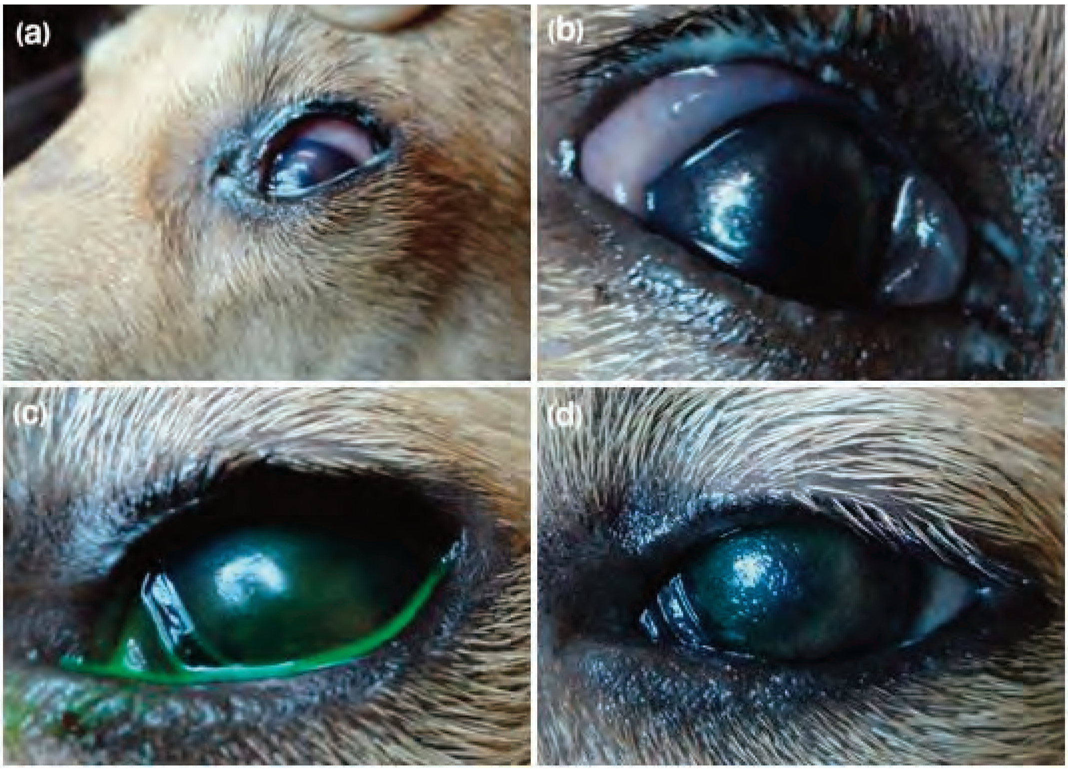

Fig. 8. Eyes of clinically affected dogs with dry-eye that used in stage II of this study: showing, left eye of greyhound (case no. 5) with dry hyperemic conjunctiva, lose of the luster of the cornea and thick mucopurlent secretion (a) Right eye of German shepherded (case no. 2) with chemosis (swelled, hyperemic conjunctiva) and accumulated white yellowish mucopurulent secretion at medial canthus of eye (b), fluorescein staining in left eye of German shepherded (case no. 7), indicating superficial keratitis as the dye pooling in the irrigular surface of the cornea (c, d).

Discussion

Canine dry-eye is a long life and a frequent eye disease in all visited dogs with reported annual average incidences of 1% (Dodi, 2015), that requires continuous management, challenging both the owner and the clinicians. The available topical medications have the disadvantages of being expensive, frequently administered and a symptomatic treatment extends throughout the animal life, so, alternative methods are required (Best *et al.*, 2014). Surgical occlusion of lacrimal puncta was described in human (Liu and Sadhan, 2002). To the best of the author knowledge, the present study would be one of the first studies that provide surgical punctal occlusion in dogs as an alternative method of refractory cases did not respond to medical treatment.

Although other surgical methods, including, parotid duct transposition (PDT) (Rhodes *et al*., 2012) and labial salivary gland autograft (Castanho *et al*., 2013), are successful methods, they are not a full replacement for medical treatment, because a low level of ongoing maintenance is still required post-operatively (Rhodes *et al*., 2012). Moreover, the main principle of these treatments is the use of saliva as a substitute of precorneal tear film, which may lead to several complications. In contrast, the surgical technique for punctal occlusion used in this study, prevented drainage of low amount of produced tear, as well as it allowed the distribution of tear over the ocular surface which greatly improve the prognosis and considered a permanent replacement of medical treatment.

Non-surgical occlusion techniques showen lower persestancy compairing to the surgical technique. This may be due to the reflex dilatation of the lacrimal canaliculi following application of silicon plugs (Williams, 2002) and /or the presence of moisture inside the canaliculi, as these animals were normal and the moisture around the polymerized adhesive can prevent intense adhesion between the tissue and the inserted objects (Rosa *et al.,* 2012), whereas, surgical occlusion, due to the removal of epithelium of puncta and lacrimal canaliculi may provide permanent adhesion of tissue, which prevent drainage of tears in comparison to other techniques of occlusion.

There are different diameters of silicon plug available commercially (0.3- 1 mm). In this study, silicon plugs of diameter 0.8 were beneficial; however, anatomical variations and breeds should be taken in considerations while repeating this method in different dogs. Silicon plugs are designed to insert inside the puncta and the first 1.5 to 2 mm of lacrimal canaliculi (Williams, 2002), in contrast, the adhesive solution used in the study can be injected more deeper and has the benefit of taking the shape of surrounding tissue, in other words, does not restrict to a particular size as silicon plugs. However, the plugs used in the study were more stable, and restrained for longer time (20-24 days) comparing to the polymerized adhesive which provide occlusion for only 12-16 days.

There are several types of cyanoacrylate that used for temporary punctal occlusion in dogs, such as ethyl-cyanoacrylate (Rosa *et al.,* 2012) butyl-cyanoacrylate and octyl-cyanoacrylate (Honsho *et al*., 2014). All these types are commercially available for medical use, but the authors select butyl-cyanoacrylate for the current study, because its polymerized (hardened) form has excellent tensile strength and is very effective as adherent for living tissues, additionally it less toxic than the other forms, in particular, the ethyl products (Ferguson *et al.,* 2003; Lee *et al.,* 2004). The catheter of 22-24 gauge used in the present study was flexible and helpful in injecting both the upper and lower puncta, while Rosa *et al*. (2012) used a needle of 25 x 7 mm cut in half to remove the cutting beveled, which was unable to inject the upper puncta and has problems with adhesive solutions and Honsho *et al*. (2014) used a 24 gauge catheter for injecting the lower puncta only.

Although drainage of tear occur mainly through lower puncta, obstruction of both puncta, is necessary, especially in cases of low STTI values. As, punctal occlusion does not increase tear production but, maintains produced tears in the tear lake (Williams, 2002, Gelatt *et al*., 2006; Cardoso *et al*., 2013; Honsho *et al*., 2014). Obstruction of lower punctum alone was not successful in clinical cases of low or zero STTI values (Williams, 2002).

In this study, the surgical method was evaluated in both normal and clinical dogs. The affected eyes show gradual improvement following surgery. Post-operative complications were limited and sutured edges did not irritate the cornea. For these, surgical punctal occlusion was successful with minimal complications, comparing to the high rate of complications associated with other surgical methods, in particular, PDT, include, blepharitis, periocular dermatitis intolerance to saliva and corneal ulceration with associated stromal mineral deposition (Rhodes *et al*., 2012). In stage II , the maximal recovery time of the clinical signs was 30 days postoperatively.

Conclusion

In conclusion, this study described three alternative methods of treatment of dry-eye in dogs, which are non-surgical temporary occlusion of puncta using silicon plugs and butyl-cyanoacrylate adhesive solution and surgical punctal occlusion, which can be used as alternative methods for unresponsive cases of medical treatment. It proved that the surgical method was superior to other described methods, and would be the treatment of choice for severe cases of canine dry-eye.

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