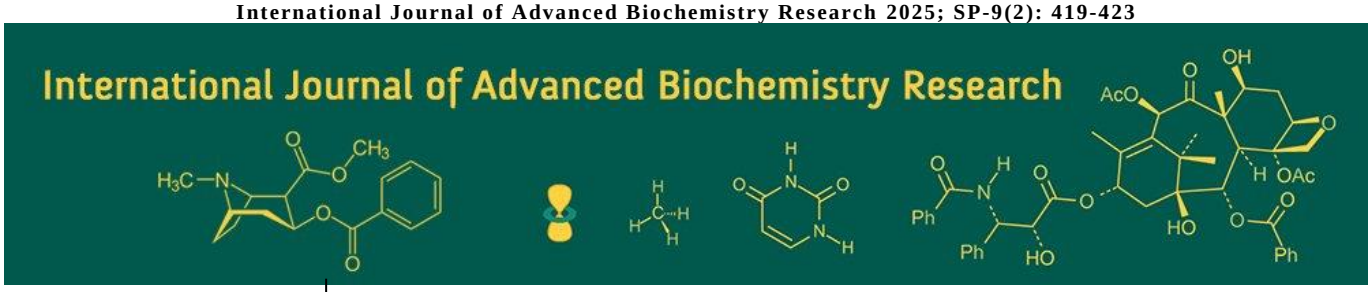

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Demographic and clinical aspects of Keratoconjunctivitis (KCS) sicca in dogs

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Abstract
This research was carried out at the Veterinary Clinical Complex, Co.V.Sc. and A.H., Jabalpur, between May and October 2024, to investigate the occurrence and clinical features of keratoconjunctivitis sicca in dogs. During the study period, a total of 2375 dogs presented at VCC, College of Veterinary Science and Animal Husbandry, Jabalpur (M.P.) from May 2024 to October 2024 were screened. Among the total number of dogs, 183 dogs were suspected based on the clinical signs pertaining to keratoconjunctivitis sicca and 18 dogs were confirmed with Schirmer tear test. The overall occurrence of KCS among the total dog population was recorded as 0.75% and among the suspected dogs, it was 9.83%. The higher occurrence was observed in dogs of 6-9 years of age group (13.04%), while gender-wise it was higher in males (10%), however, these findings were non-significant. Among different breeds, Pug had a significantly higher occurrence (23.08%) followed by Lhasa Apso (20%) and Shih Tzu (7.69%). The prevalent clinical signs observed in KCS were dullness of cornea (100%) followed by mucopurulent discharge (88.88%) and eye irritation (83.33%). Bilateral KCS predominated (83.33%) while unilateral cases affected the right eye in 11.11% and the left in 5.55%

Keywords: KCS, dogs, prevalence, Schirmer tear test, dry eye

Introduction
Keratoconjunctivitis sicca (KCS) commonly known as “dry eye” is a chronic, inflammatory ophthalmic disorder that commonly occurs in dogs. It is characterized by a quantitative decrease in the tear film's aqueous layer and qualitative deficiency in the lipid or mucin layer. It results in a progressive inflammatory process that primarily affects the cornea, conjunctiva and lacrimal glands (Zulim *et al*., 2018) [21]. The preocular tear film plays a vital role in maintaining the health of the ocular surface. It supplies essential nutrients such as oxygen, glucose and electrolytes to the avascular cornea, lubricates both the eyelids and the ocular surface, delivers protective antimicrobial proteins, immunoglobulins, growth factors and facilitates the removal of debris and exfoliated cells (Dodi *et al*., 2009) [8]. Blepharospasm, thick mucoid ocular and periocular discharge, conjunctival hyperemia and corneal abnormalities such as fibrosis, pigmentation, vascularization and severe ulceration are the clinical symptoms of this condition (Dees and Kent, 2020) [7]. In KCS, compensatory changes include conjunctival cell hyperplasia to offset the reduced aqueous tear film. The resulting hypertonic tear film in the acute phase dehydrates the ocular surface, causing epithelial edema, vacuolar degeneration and thinning. Increased friction from blinking over a rough, keratinized conjunctiva leads to corneal ulcers, which are vulnerable to infection, keratomalacia and perforation. Chronic irritation causes conjunctival hyperemia, chemosis and epithelial squamous metaplasia with hyperkeratinization which leads to impaired vision (Best *et al*., 2014) [4]. Primary causes of KCS in dogs is an autoimmune disorder that affects the lacrimal gland. Other potential causes include drug toxicity (sulphonamides), drug-induced (atropine), congenital, metabolic, infectious, neurogenic, radiation, iatrogenic (excision of nictitans gland) and idiopathic. Ageing, breed propensity in dogs with brachycephalic heads, hormone fluctuations and systemic illnesses are risk factors for KCS (John *et al*., 2018) [10]. Brachycephalic breeds, spaniels and older dogs have increased odds of developing KCS (O'Neill *et al*., 2021) [16].

The diagnosis of KCS in dogs relies on the identification of persistent clinical symptoms and the assessment of pre-corneal tear film through methodologies such as the Schirmer tear test (STT-I) and Tear Film Break-Up Time (TFBUT) measurement (Avci *et al*., 2024) [2]. When the Schirmer tear test (STT-I) measurement is less than 15 mm/minute accompanied by clinical signs is suggestive of KCS (Giuliano and Moore, 2007) [12]. The tear film break-up time test (TFBUT) will measure the quality of the tear film by breaking the tear film stained with fluorescein. The objective of this study was the occurrence of keratoconjunctivitis sicca in dogs treated at the Veterinary Clinical Complex, Co.V.Sc. and A.H., Jabalpur, between May 2024 and October 2024.

Materials and Methods

Location and place of work

The proposed study was conducted for a duration of six months from May 2024 to October 2024 in the Department of Veterinary Medicine, College of Veterinary Science and Animal Husbandry, Nanaji Deshmukh Veterinary Science University (N.D.V.S.U.), Jabalpur, Madhya Pradesh (M.P.).

Screening

For this study, a total of 2375 dogs irrespective of age, breed and sex presented at Veterinary Clinical Complex, College of Veterinary Science and Animal Husbandry, Jabalpur (M.P.) from May 2024 to October 2024 were screened. Among the total number of dogs, 183 dogs were suspected on the basis of clinical signs pertaining to KCS like blepharospasm, ocular and periocular discharge, conjunctivitis, fibrosis, pigmentation, vascularisation and ulceration of cornea and 18 dogs were confirmed by Schirmer tear test (STT-I) to record the occurrence of KCS. STT-I value less than 10mm/min was taken as positive cases.

Statistical analysis

A chi-square test was used to analyzed the collected data following the standard procedure described by Snedecor and Cochran (1994) [18].

Results and Discussion

Overall occurrence of Keratoconjunctivitis sicca in dogs

During this timeframe, a total of 2,376 dogs were examined, among which 183 dogs exhibited clinical signs indicative of KCS like blepharospasm, ocular and periocular discharge, conjunctivitis, fibrosis, pigmentation, vascularisation and ulceration of cornea were screened. Within this subset, 18 dogs were diagnosed with KCS by Schirmer tear test. The overall occurrence of KCS in the dog population was 0.75% (18/2376) whereas occurrence among suspected dogs was 09.83% (18/183). The results are illustrated in (Table 1).

The findings of this study are consistent with those of Guandalini *et al*. (2018) [9], Palmer *et al*. (2021) [17] and Tsvetanova *et al*. (2021) [20] who reported overall KCS prevalence rates in dogs were 08.61%, 10.20% and 11.00%, respectively. In contrast, John *et al*. (2020) [11] and O'Neill *et al*. (2021) [16] observed lower KCS rates, with prevalence of 03.33% and 0.40%, respectively.

The variation in KCS rates might be due to differences in the number of samples tested, climate, the immune status of dogs, breed predispositions and diagnostic methods that influence reported cases.

Table 1: Overall occurrence of Keratoconjunctivitis sicca in dogs

Particulars	Number screened	Number affected	Occurrence (%)
Total dogs	2376	18	0.75
Suspected dogs	183	18	9.83

Age wise occurrence of Keratoconjunctivitis sicca in dogs

The highest proportion of cases occurred in the age group 6 to 9 years, making up 13.04% (06/46) of the total cases. This was followed by 3 to 6 year age group representing 11.36% (05/44) and those over 9 years, representing 10.41% (05 out of 48) of the cases. The youngest age group, under 3 years, accounted for the smallest share, comprised 04.44% (02/45) of the total cases. Although, age wise occurrence of KCS in dogs varied non significantly. The details are summarized in (Table 02).

The findings of this study are in agreement with O'Neill *et al*. (2021) [16] and Febina *et al*. (2021) [13], who reported that 29.47% and 72.70% of dogs diagnosed with KCS were 6 to 9 years old. In contrast, Anoop *et al*. (2015) [1] observed that Pugs under the age of 3 years were most frequently affected. Similarly, John *et al*. (2018) [10] and Swapana *et al*. (2020) [19] documented a higher prevalence among dogs aged between 1 to 5 years.

This susceptibility might be due to the natural decline in tear production associated with ageing, as well as the increased likelihood of underlying health issues that can affect the tear glands. Additionally, poor hygiene and improper care by owners can delay the recognition and treatment of the condition, particularly when infections are involved.

Table 2: Age wise occurrence of Keratoconjunctivitis sicca in dogs

Age group (Years)	Number screened (n=183)	Number affected (n=18)	Occurrence (%)
<3	45	02	04.44
3-6	44	05	11.36
6-9	46	06	13.04
>9	48	05	10.41
$\chi^2 = 2.143^{NS}$, p value= 0.54 Non-significant at $p \geq 0.05$			

Gender-wise occurrence of Keratoconjunctivitis sicca in dogs

KCS was predominantly observed in male dogs, accounted for 10.00% (110/11) of the recorded cases, while female dogs accounted for 09.50% (07/73) of the cases in the present study. Although, gender wise occurrence of KCS in dogs varied non significantly. The details are summarized in (Table 3).

The current findings were similar to those of O'Neill *et al*. (2021) [16], Swapana *et al*. (2020) [19] and Chaithra *et al*. (2024) [5] who observed a higher prevalence of KCS in male dogs, accounted for 50.34%, 65.20% and 57.00%, respectively. In contrast, the results differed from those of John *et al*. (2018) [10] Dees and Kent (2020) [7] and Febina *et al*. (2021) [13], who reported a higher prevalence in female dogs.

Tear deficiency in males and females have no significant difference in proportion. Higher occurrence among male dogs may be attributed to a greater number of males being presented to the clinics or people preferring males over female dogs.

Table 3: Gender wise occurrence of Keratoconjunctivitis sicca in dogs

Gender	Number screened (n=183)	Number affected (n=18)	Occurrence (%)
Male	110	11	10.00
Female	73	07	09.50
$\chi^2 = 0.008^{NS}$, p value = 0.92 Non-significant at $p \geq 0.05$			

Breed wise occurrence of Keratoconjunctivitis sicca in dogs

The distribution of KCS cases among dog breeds showed that Pugs were the most affected, accounting for 23.80% (10/42) of cases. This was followed by Lhasa Apso 20% (02/10), Shih Tzu 07.69% (02/26) Spitz 06.66% (01/15), Labrador Retriever 03.92% (02/51) and non-descript breeds 02.56% (01/39). The details are summarized in (Table 04)

The present findings were similar to the work of John *et al*. (2018) [10], Febina *et al*. (2021) [13] and Chaithra *et al*. (2024) [5] who reported a higher occurrence of KCS in Pugs (82%), (36%) and (56.40%), respectively. However, these results contradict those of Liu *et al*. (2014) [14] who found that most of the cases involved English Cocker Spaniels, Cavalier King Charles Spaniels, West Highland White Terrier and Shih Tzus.

The higher occurrence of KCS in the present study might be due to its susceptibility to ophthalmic diseases due to their conformational abnormalities, such as exophthalmos and lagophthalmos, which contributed to increased tear evaporation and reduced corneal sensitivity, making the tear film unstable and increasing the risk of dry eye.

Table 4: Breed wise occurrence of Keratoconjunctivitis sicca in dogs

Breed	Number screened (n=183)	Number affected (n=18)	Occurrence (%)
Pug	42	10	23.80
Lhasa Apso	10	02	20.00
Shih Tzu	26	02	07.69
Spitz	15	01	06.66
Labrador Retriever	51	02	03.92
Non-descript	39	01	02.56
$\chi^2 = 15.054$*, p value = 0.010 *Significant at $p \leq 0.05$			

Eye wise distribution of Keratoconjunctivitis sicca in dogs

The dogs during the study of KCS were examined for unilateral and bilateral KCS. Out of total dogs positive for KCS, bilateral KCS was recorded in 15 out of 18 dogs i.e., 83.33% and unilateral KCS was recorded in 3 out of 18 dogs i.e., 16.67%. with the right eye affected in 02 out of 18 dogs i.e., 11.11% and the left eye affected in 01 out of 18 dogs i.e., 05.55%. The results are summarized in (Table 05).

These findings aligned with those of Morgan and Abrams (1991) who reported that 20 dogs (33.33%) exhibited unilateral KCS, while 40 dogs (66.66%) had bilateral KCS. Balicki *et al*. (2008) [3], reported a higher incidence of bilateral KCS being involved, with rates of (82.50%). Ofri *et al*. (2009) [15] enrolled 44 dogs in the study on KCS in which 11 were diagnosed with unilateral disease and 33 dogs with bilateral disease.

KCS in dogs is generally bilateral and it might be due to its immune-mediated origin, which causes inflammation and lead to damage of the lacrimal glands in both eyes, as evidenced by histopathological findings of lymphocytic infiltration leading to reduced tear production. Although some cases, such as neurogenic KCS or those linked to previous injuries, may affect only one eye.

Table 5: Eye wise distribution of Keratoconjunctivitis sicca in dogs

Affected eye		No. of dogs (n=18)	Percent (%)
Bilateral		15	83.33
Unilateral	Right	02	11.11
	Left	01	05.55

4.8 Ocular manifestations in dogs affected with Keratoconjunctivitis sicca

The affected dogs exhibited clinical signs such as dullness of cornea as observed in 100% dogs (18 out of 18), followed by mucopurulent discharge in 88.88% dogs (16 out of 18), eye irritation in 83.33% dogs (15 out of 18), conjunctival hyperemia in 66.66% dogs (12 out of 18), corneal opacity in 55.55% dogs (10 out of 18), corneal neovascularization in 38.88% dogs (07 out of 18), corneal pigmentation in 33.33% dogs (06 out of 18 dogs), blepharospasm in 22.22% (04 out of 18 dogs), corneal ulcer in 11.11% dogs (02 out of 18) and chemosis in 06.66% dogs (1 out of 18) the results are shown in (Table 6) and figure 1.

These observations in present study coincided with the findings of various scientists viz. Balicki *et al*. (2008) [3] and Crasta *et al*. (2022) [6] who reported that the dogs diagnosed with KCS showed mucopurulent ocular discharge, blepharospasm, conjunctival congestion and edema along with other clinical signs like corneal dryness, opacity, neovascularization, photophobia, pigmentation, ulceration of cornea and blindness.

In the present study, the emergence of clinical signs might be due to a deficiency in the precorneal tear film, leading to chronic irritation of the ocular surface resulted in conjunctival hyperemia, squamous metaplasia of the surface epithelium, hyperkeratinization and thickening of the corneal epithelium. Inflammatory cells and blood vessels infiltrate the anterior corneal stroma, resulting in the deposition of pigment, lipids and calcium. These changes help to protect the cornea from ulcers but can also lead to vision problems. Discomfort from these conditions may cause blepharospasm, secondary infections corneal dehydration and malnutrition. Insufficient lubrication often triggers increased mucin production, leading to a mucoid or mucopurulent discharge, which can become infected over time. Chronic inflammation further exacerbates the situation, potentially causing corneal vascularization, pigmentation and ulceration, ultimately affecting vision and overall comfort. The symptoms of KCS vary with its severity. In mild cases, there may be minimal redness and a clear discharge. Moderate KCS often leads to more noticeable redness, a thick, mucus-like discharge and squinting. Severe cases are characterized by marked redness, discomfort, excessive blinking, corneal ulcers and potential vision problems caused by scarring and the development of neovascularization.

Table 6: Ocular manifestations in dogs affected with Keratoconjunctivitis sicca

Ocular signs	Number of dogs (n=18)	Percent (%)
Dullness of cornea	18	100.00
Mucopurulent discharge	16	88.88
Eye irritation	15	83.33
Conjunctival hyperemia	12	66.66
Corneal opacity	10	55.55
Corneal neovascularization	07	38.88
Corneal pigmentation	06	33.33
Blepharospasm	04	22.22
Corneal ulcer	02	11.11
Chemosis	01	06.66

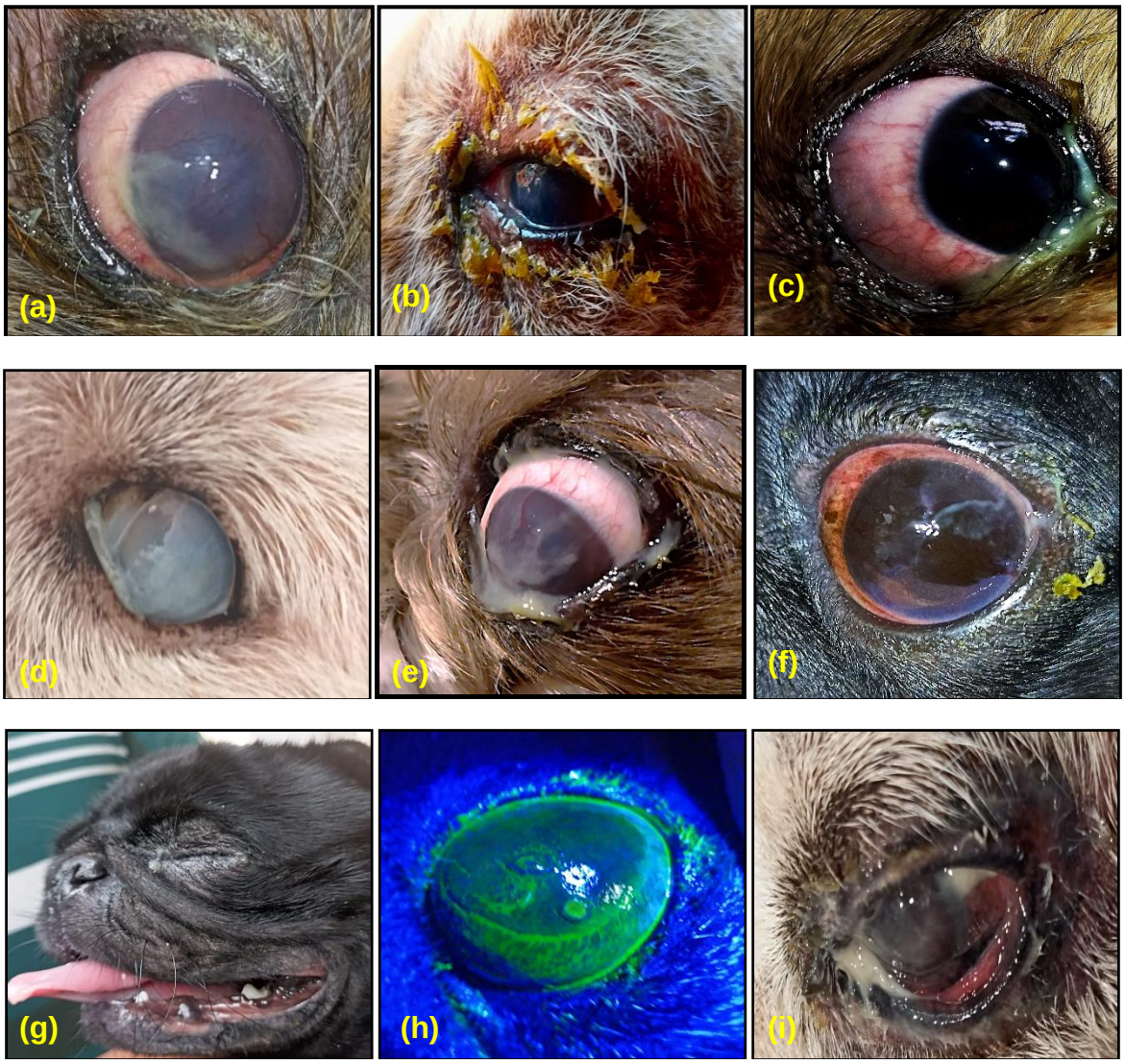

Fig 1: Ocular manifestations in dogs affected with Keratoconjunctivitis sicca (a)Dullness of cornea (b) Mucopurulent discharge (c) Conjunctival hyperemia (d) Corneal opacity (e) Corneal neovascularization (f) corneal pigmentation (g) Blepharospasm (h) Corneal pigmentation (i) Chemosis

Conclusion

The demographic study on keratoconjunctivitis sicca (KCS) in dogs revealed an overall occurrence rate of 0.75% in the general population, with a notably higher rate of 9.83% among suspected cases. The higher occurrence was seen in dogs of 6-9 years of age group while gender wise it was higher in males, however, these findings were non-significant. Breed-specific analysis highlighted Pugs as significantly predisposed to KCS. Dogs with bilateral KCS were far more common than unilateral cases. Clinically, all KCS-positive dogs exhibited corneal dullness followed by mucopurulent discharge, eye irritation, and conjunctival hyperemia being among the most frequently observed signs. Other notable findings included corneal opacity, corneal neovascularization, corneal pigmentation, blepharospasm, corneal ulcer and chemosis. These findings emphasize the breed-specific and clinical variability of KCS in dogs, suggesting the need for early diagnosis and targeted management strategies.

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