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A review on incidence of different components in brachycephalic ocular syndrome in dogs

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Abstract
Brachycephalic Ocular Syndrome (BOS) encompasses ophthalmic disorders associated with brachycephalic breeds, including exophthalmos, lagophthalmos, macropalpebral fissure, medial entropion, trichiasis, nasal fold trichiasis, corneal ulceration, pigmentary keratitis, tear film abnormalities, and progressive vision loss. This study evaluated 500 brachycephalic dogs at Madras Veterinary College for BOS, with detailed ophthalmic assessment including scleral 'show', eyelid closure, palpebral fissure measurement, entropion grading, nasal fold thickness, Schirmer tear tests (STT I and II), tear break-up time (TBUT), and corneal mapping. Out of 382 dogs with BOS, Pugs were the most affected breed (92.8%). Pigmentary keratitis (39.29%) and medial entropion (31.94%) were most frequent, with tear film deficiency predisposing dogs to ocular surface disease. Findings indicate a strong correlation between eyelid conformation abnormalities, nasal fold trichiasis, and corneal pathology. Early surgical intervention and tear film management are crucial for halting progressive corneal damage and preserving vision in affected dogs.

Keywords: KCS, lagophthalmos, ocular syndrome, pigmentary keratitis, medial entropion

Introduction
Brachycephalic syndrome (BS) is a recognized disorder in brachycephalic dogs, primarily affecting the upper airway due to skull conformation abnormalities such as stenotic nares, elongated soft palate, hypoplastic trachea, and everted laryngeal saccules (Schneider *et al.*, 2013; Liu *et al.*, 2017) [14, 7]. Beyond respiratory compromise, brachycephalic dogs are predisposed to ocular disorders due to shallow orbits, prominent globes, and skin fold conformation, collectively termed brachycephalic ocular syndrome (BOS), (Packer *et al.*, 2015; Maini *et al.*, 2019) [10, 9]. BOS encompasses exophthalmos, lagophthalmos, macropalpebral fissure, medial entropion, trichiasis, nasal fold trichiasis, corneal ulceration, pigmentary keratitis, tear film abnormalities, and progressive vision loss. Exophthalmos and macropalpebral fissure increase risk of corneal trauma, while medial entropion and nasal fold trichiasis contribute to chronic corneal irritation and pigmentary keratitis (Maini *et al.*, 2019) [9]. Tear film deficiency, assessed via Schirmer tear test (STT I & II) and tear break-up time (TBUT), further predisposes to ocular surface disease (Best *et al.*, 2014; Cullen *et al.*, 2005; Maggs, 2008; Barabino *et al.*, 2004) [3, 4, 8, 2]. This study aimed to document ophthalmic components of BOS, assess tear film quality, eyelid conformation, and corneal pigmentation in brachycephalic breeds presenting to a tertiary veterinary hospital.

Materials and Methods
The study was conducted on 500 brachycephalic dogs (BD) presented to the Small Animal Teaching Hospital, Madras Veterinary College. Dogs showing ocular, respiratory, skeletal, or digestive manifestations of brachycephaly were included, while those with dermatological, urinary, obstetric, or other unrelated conditions were excluded. Ophthalmic evaluation was performed in all included dogs (N=313) and comprised several parameters.

Ocular examination focused on assessing features of brachycephalic ocular syndrome, including exophthalmos, lagophthalmos, macropalpebral fissure, medial entropion, redundant nasal folds, pigmentary keratitis, and tear film abnormalities. Exophthalmos was evaluated by observing the scleral 'show', which involved noting the visibility of the white of the eyes (sclera) in medial, lateral, dorsal, and ventral quadrants while the dog's attention was held by a toy or treat; dogs were not restrained to avoid artificially exposing sclera. A score of 0-4 was assigned based on the number of quadrants of visible sclera (Packer *et al*., 2015) [10]. Lagophthalmos, defined as incomplete closure of the eyelids, was recorded based on owner observation when the animal was completely at rest or asleep. The width of the macropalpebral fissure, measured as the distance between medial and lateral canthus, was recorded in millimeters using a blunt-ended Jameson calliper (Maini *et al*., 2019) [9]. Medial entropion was examined at the lower eyelid, particularly at the medial canthus, for inversion and contact of eyelid hairs with the cornea, and graded as Grade I when hairs contacted the cornea predominantly in one direction, and Grade II when hairs crossed in both directions (Maini *et al*., 2019) [9]. Redundant nasal folds were measured in millimeters using Jameson callipers, taking care to avoid inadvertent corneal contact. Tear production and ocular surface evaluation included Schirmer tear test I (STT I), Schirmer tear test II (STT II), and tear film break-up time (TBUT). STT I, performed in conscious dogs, measured basal and reflex tear production using 5 mm × 35 mm filter paper strips marked in 1 mm increments; strips were placed in the lower conjunctival fornix for one minute and tear production recorded in mm/min. Values of ≥ 15 mm/min were considered normal, 11-14 mm/min as mild or subclinical reduction, 6-10 mm/min as moderate, and ≤ 5 mm/min as severe *keratoconjunctivitis sicca* (KCS) with epiphora (Whittaker and Stanley, 2007) [13]. STT II, performed after topical anesthesia with 2% Proparacaine, measured basal tear production alone (Dodi, 2015) [5]. TBUT assessed tear film stability qualitatively using fluorescein staining, observed under slit-lamp biomicroscope with cobalt blue filter; normal TBUT ranged from 15-20 seconds, while values below 10 seconds indicated tear film instability (Tapping, 2020) [12]. Pigmentary keratitis was graded using corneal mapping, dividing the cornea into 12 sectors ('clock hours'), assigning one point per affected sector, half a point for single pigment lines, and additional points if pigmentation extended to or beyond the resting pupil edge, with total scores classified as mild (0.5-4.5), moderate (5-9.5), or severe (10-14), (Maini *et al*., 2019) [9]. All measurements were recorded systematically, and photographic documentation was performed to ensure accurate grading and evaluation of ocular abnormalities.

Results

A total of 313 Brachycephalic Dogs (BD) presenting with ophthalmic components of Brachycephalic Syndrome (BS) were evaluated in this study. Among these, pigmentary keratitis was the most prevalent ocular abnormality, observed in 123 dogs (39.29%), followed by median entropion in 100 dogs (31.94%), exophthalmos in 58 dogs (18.53%), corneal ulceration in 47 dogs (15.01%), redundant nasal folds in 39 dogs (12.46%), lagophthalmos in 14 dogs (4.47%), and *keratoconjunctivitis sicca* (KCS) in 4 dogs (1.27%), (Table 1).

Plate 1: Ocular Manifestations in Brachycephalic Ocular Syndrome (BOS)

Fig 1: Macropalpebral fissure demonstrating increased palpebral width in a brachycephalic dog

Fig 2: Redundant nasal folds measured using Jameson calipers

Fig 3: Lagophthalmos showing incomplete eyelid closure in a resting dog.

Fig 4: Corneal ulcer with associated pigmentary keratitis.

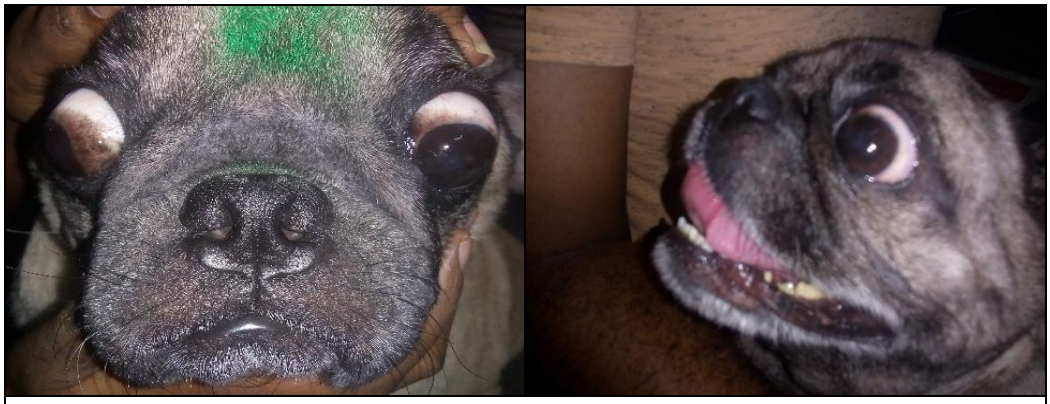

Fig 5: Excessive scleral show indicative of exophthalmos in a brachycephalic dog.

Table 1: Incidence of ophthalmic components of bs in 313 dogs

Breed	Exophthalmos	Lagophthalmos	Corneal Ulcer	Median Entropion	Redundant Nasal Fold	Pigmentary Keratitis	KCS
Pug	57	12	42	98	37	120	-
Boxer	-	-	1	-	-	-	-
Shih Tzu	1	2	1	-	2	2	4
Lhasa Apso	-	-	2	-	-	-	-
Bulldog	-	-	-	-	-	1	-
Pekingese	-	-	1	2	-	-	-
Total	58	14	47	100	39	123	4

Breed-wise analysis revealed that Pugs accounted for the majority of cases with exophthalmos (57 dogs), median entropion (98 dogs), redundant nasal folds (37 dogs), and pigmentary keratitis (120 dogs). Shih Tzus demonstrated lower incidence of these conditions, while Boxers, Bulldogs, Lhasa Apsos, and Pekingese showed sporadic involvement (Table 1, Plate 1).

Exophthalmos was quantified using scleral show scoring in a subset of 60 dogs. Shih Tzus exhibited the highest mean scleral show score (3.21±0.024), while Pugs had a mean of 2.01±0.023. Lhasa Apso, Bulldog, and Pekingese dogs had lower scores (1.0) and Boxers showed no visible scleral show in this subset (Table 2).

Table 2: Exophthalmos in BD (N=60) scleral show scores

Breed	Mean ± SE	Total Dogs
Pug	2.01±0.023	37
Boxer	0	6
Shih Tzu	3.21±0.024	8
Lhasa Apso	1.0	2
Bulldog	1.0	6
Pekingese	1.0	1
Total	-	60

Lagophthalmos was assessed based on owner observation, and incidence was highest in Pugs (34/37 dogs; 91.8%), followed by Shih Tzus (6/8 dogs; 75%) and Bulldogs (1/6 dogs; 16.6%). No cases were observed in Boxers, Lhasa Apsos, or Pekingese (Table 3).

Table 3: Lagophthalmos in BD (N=60)

Breed	No of Dogs	Incidence (%)
Pug	34	91.8
Boxer	0	0
Shih Tzu	6	75
Lhasa Apso	0	0
Bulldog	1	16.6
Pekingese	0	0
Total	41	68.3

The mean unstretched macropalpebral fissure width was largest in Pugs (OD: 2.53±0.17 cm, OS: 2.18±0.159 cm) and Shih Tzus (OD: 2.40±0.075 cm, OS: 2.41±0.064 cm), predisposing these breeds to lagophthalmos and ocular surface disorders. Boxers and Bulldogs had slightly smaller fissure widths, while Lhasa Apso and Pekingese exhibited the smallest measurements (Table 4).

Table 4: Macropalpebral Fissure Width (cm) in BD

Breed	OD (Mean ± SE)	OS (Mean ± SE)
Pug	2.53±0.17	2.183±0.159
Boxer	2.33±0.051	2.43±0.051
Bulldog	2.367±0.051	2.383±0.051
Shih Tzu	2.40±0.075	2.413±0.064
Lhasa Apso	2.3	2.45±0.070
Pekingese	2.2	2.3

Medial entropion was observed in 30 dogs (50% of the subset), with Grade I entropion most common in Pugs (23 dogs) and Shih Tzus (7 dogs), and Grade II entropion recorded in 14 Pugs and 1 Shih Tzu. No entropion was noted in Lhasa Apso, Bulldog, or Pekingese in this subset (Table 5).

Table 5: Medial Entropion in BD (N=60)

Breed	Total Dogs Examined	Grade I	Grade II
Pug	37	23	14
Boxer	6	0	0
Shih Tzu	8	7	1
Lhasa Apso	2	0	0
Bulldog	6	0	0
Pekingese	1	0	0
Total	60	30	15

Redundant nasal folds were most frequently observed in Pugs (37 dogs), with 5 showing continual folds and 2 positional folds. Bulldogs exhibited 2 cases of positional folds, while the remaining breeds had minimal incidence (Table 6). Overall, Pugs were the most affected breed across all ophthalmic components of BS, indicating a strong breed predisposition.

Correlation of pigmentary keratitis with medial entropion and redundant nasal folds was evident, suggesting that eyelid conformation and nasal fold trichiasis significantly contribute to ocular surface pathology.

Table 6: Redundant Nasal Folds in BD (N=60)

Breed	Continual	Positional	Total
Pug	5	2	37
Boxer	0	0	6
Shih Tzu	0	0	8
Lhasa Apso	0	0	2
Bulldog	0	2	6
Pekingese	0	0	1

Discussion

Brachycephalic ocular syndrome (BOS) is a multifactorial condition commonly observed in brachycephalic breeds, encompassing a spectrum of conformational and ocular abnormalities including exophthalmos, lagophthalmos, macropalpebral fissure, medial entropion, redundant nasal folds, trichiasis, pigmentary keratitis and tear film deficiencies. These structural anomalies predispose affected dogs to chronic ocular surface disease, corneal ulceration and progressive visual impairment (Maini *et al.*, 2019; Packer *et al.*, 2015) [9, 10]. Our study evaluated 313 brachycephalic dogs and found a high prevalence of BOS, with Pugs being the most affected breed, followed by Shih Tzus, Boxers, Bulldogs, Lhasa Apsos, and Pekingese.

Exophthalmos was more pronounced in Shih Tzus and Pugs, consistent with Packer *et al.* (2015) [10], and predisposes to corneal desiccation and ulceration. Shih Tzus exhibited the highest scleral show scores (3.21±0.024), while Pugs also demonstrated considerable scleral exposure (2.01±0.023). Lagophthalmos, particularly in Pugs (91.8% incidence), further increases the risk of exposure keratopathy, aligning with findings by Douglas *et al.* (2015). Larger macropalpebral fissure widths in Pugs (OD: 2.53±0.17 cm, OS: 2.18±0.159 cm) and Shih Tzus (OD: 2.40±0.075 cm, OS: 2.41±0.064 cm) exacerbate these risks, correlating with *keratoconjunctivitis sicca* (KCS), tear film instability, and pigmentary keratitis. These observations highlight the compounding effect of ocular conformation on corneal health in brachycephalic breeds.

A strong association was observed between medial entropion, redundant nasal folds, and pigmentary keratitis, particularly in Pugs. Medial entropion was present in 32.4% of Pugs and 25% of Shih Tzus, while redundant nasal folds occurred predominantly in Pugs (37 dogs). This triad of abnormalities contributes to chronic corneal irritation via trichiasis and mechanical trauma, emphasizing the need for early surgical correction to prevent irreversible corneal damage, as noted by Maini *et al.* (2019) [9].

Tear film evaluation using Schirmer tear tests I and II and tear break-up time (TBUT) revealed significant reductions in both basal and reflex tear production. The mean STT values were lower than the reference range of ≥ 15 mm/min (Whittaker and Stanley, 2007) [13], indicating a predisposition to chronic corneal disease. Similarly, TBUT was markedly reduced (< 10 sec), reflecting tear film instability and increased susceptibility to exposure keratopathy (Best *et al.*, 2014; Cullen *et al.*, 2005; Maggs, 2008; Barabino *et al.*, 2004) [3, 4, 8, 2]. These findings underscore the functional impact of BOS on ocular surface homeostasis, beyond the visible structural anomalies.

Age-wise trends demonstrated increasing severity of ocular involvement with advancing age. Dogs older than 8 years exhibited the highest incidence of pigmentary keratitis, median entropion, and corneal ulceration, supporting the progressive nature of BOS. Breed predisposition and age-related severity indicate that both congenital conformation and chronic mechanical irritation contribute to long-term ocular pathology. Preventive strategies, including early surgical correction of entropion and redundant nasal folds, combined with proactive management of tear film deficiencies, remain crucial for preserving corneal health and vision. In clinical practice, periodic ophthalmic evaluations and owner education regarding early signs of BOS can mitigate disease progression and improve the quality of life for affected dogs.

Conclusion

Brachycephalic ocular syndrome is highly prevalent in brachycephalic dogs, especially Pugs, and manifests as pigmentary keratitis, medial entropion, exophthalmos, and tear film deficiency. Early recognition and surgical intervention are critical to prevent irreversible corneal damage. Routine ophthalmic screening in brachycephalic breeds is recommended to maintain ocular health and quality of life. Tear film evaluation is essential for planning medical and surgical management.

Conflict of Interest

Not available

Financial Support

Not available

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