STUDY OF TEAR PRODUCTION IN DOGS, USING THE SCHIRMER TEST IN THE PROVINCE OF BOLIVAR (ECUADOR)

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Abstract - The present investigation was carried out in order to study tear production in dogs using the Schirmer test in the province of Bolívar, Ecuador. Wherefore, 394 samples were taken at random, in the 7 cantons of the province. A previous analysis of the different cantons to visit was carried out, to determine where there was a higher concentration of dogs, from which samples were to be taken. Once the patients had been identified, the medical file was filled out, which contains the owner's data, dog data, date, place, physiological constants, and data on the production of each right and left eye. After a previous evaluation, where the animal's state of health is considered, the tear production of each right and left eye was quantified for one minute. With the research work carried out, it was possible to establish tear production values in dogs in the evaluation area. Through the statistical analysis, different tear production values were determined according to the shape of the skull, according to age, and according to the right and left eye. It could be concluded that the Schirmer test, is a simple and an effective diagnostic method to determine the degree of tear production in canines.

Keywords: Schirmer, tear prodcution, dogs, Schirmer test

INTRODUCTION

The most common way to assess tear production is the Schirmer tear test, in which standardized strips of filter paper are used to quantify the production of the aqueous portion of the tear. There are significant differences between values obtained in anesthetized eyes (Schirmer I) and non-anesthetized eyes (Schirmer II), where the normal reading in dogs and cats is 20 ± 5 millimeters per minute (**Huaringa et al., 2015; Williams, and Burg, 2017**).

Lacrimal and nasolacrimal system diseases are common in dogs and can be successfully treated if diagnosed early (**Gelatt, Atlas de Oftalmología veterinaria, 2003).** Dry eye is a consequence of tear deficiency or increased loss of evaporation (**Huaringa et al., 2015**). If the quality of the tear film decreases or the film is non-existent, the cornea suffers and repair processes begin, tear deficiency or dry keratoconjunctivitis is the most frequent chronic conjunctivitis in dogs. The Schirmer test can increase the clinical detection of this disease. (**Cabrera Hoyos et al., 2017**). Keratoconjunctivitis sicca (KCS), also known as Dry eye syndrome (DES) is a common ophthalmopathy, often confused with bacterial or nonspecific conjunctivitis. When this problem is not solved in a short time and without specific therapy it evolves into progressive corneal opacity and blindness, hence the importance of performing a tear production test such as the tear test of the Schirmer method, to verify if the dry eye is due to a decrease in tear production. For this test, it is important to take into consideration the race of the patient, since many times there is a strong association between diseases and races (**Visser et al., 2017**).

The Schirmer test was a refinement of the **Köster test (1900),** the Köster test consisted of placing a 10 x 10-20 mm strip of paper in the conjunctival sac, and performing the measurement. Schirmer (1903) modified this test. Thus, he devised 3 methods to quantify tear secretion (**Aftab et al., 2018**).

Schirmer's test (STT)
Determines if the eye produces enough tears to stay moist, this test uses standardized filter paper strips to quantify the aqueous production of the tear. The short end of the strip is then inserted into the lateral half of the lower conjunctival sac; the notch remains at the level of the lid margin and thus the strip is in contact with the lower eyelid and with the cornea. (**Huaringa et al., 2015**).

Schirmer I test: measures aqueous production for one minute in a non-anesthetized eye, therefore, it measures basal tear production and reflects it. Normal values for this test in the dog are a mean of 20 mm, with a minimum of 15 mm. Patients in the 10-15mm range are designated borderline or borderline, but authoritative changes and changes due to dry eye are sometimes found in dogs with values less than 15 mm. The Schirmer I test has proven to be the most useful in veterinary ophthalmology. (**Trbolova et al., 2017**).

Schirmer II test: it only measures basal tear production, since it eliminates the reflex tear production produced by the contact of the strip with the cornea and with the conjunctiva.

In this case, local anesthesia is applied, the excess is removed with gauze or cotton and we wait a few minutes for it to take effect. The values are lower than for the Schirmer I test, but normally they will not be less than 50% in dogs. The Schirmer II test is used in human patients, where high reflex tear production may mask basal production. This situation probably also occurs in animals, but this test is not normally done (**Petersen – Jones, 2012; Ghislandi and Lima, 2016)**.

After the theoretical analysis, the objective of this work was: To study tear production in dogs, using the Schirmer test, in the province of Bolivar, Ecuador.

MATERIALS AND METHODS

The present investigation was carried out in the 7 cantons of the province of Bolivar, wherefore, a type of descriptive study was carried out, with which tear production in dogs was evaluated. Consequently, an anamnesis was carried out on the owners of the dogs, and the patient's health status was evaluated, who, to carry out the study, did not receive a dose of tranquilizer for handling during the procedure, only a muzzle was used for security. To carry out this research, 394 samples were used.

Statistical Analysis

The information analysis was carried out with the application of descriptive statistics and the use of statistical software. The research was analyzed with central tests of dispersion, shape, and correlation such as frequency, mean, median, and variance).

Methods And Techniques

- Once the visit to the different cantons of the province had been carried out, identifying the places with the highest canine concentration, each dog was located for the study, previously the owners were informed about the research and data was collected.
- It was started by holding the patient and making a study of all the systems, anamnesis of the owner taking physiological constraints. The type of skull was analyzed. (Dolichocephalic, brachycephalic, mesocephalic). Auscultation of the thoracic cavity using palpation and instruments such as the stethoscope, reviewing any type of problem that intervenes in the development of the investigation. Palpation of the abdomen, bladder and other organs verifying their normal functioning. To complete the clinical examination, the rectal temperature of each of the patients was taken.
- The ocular cavity was explored and auscultated.

- The Schirmer tape was applied in each eye between the ocular globule and the lower palpebral conjunctiva, leaving it to act for a few minutes, and then the reading was made and compared with the reference values.
- The data of the patients were recorded during the investigation, the data were entered in the medical records and subsequent analysis.

Primary information. - The data obtained by taking the anamnesis of the dog owners, and subsequent routine check-up that is performed on the patients in a normal consultation, in addition to the results of the Schirmer test performed on each domestic dog, were considered.

Secondary information. - The information obtained through reference books, magazines, internet, thesis, etc. was used.

Variables To Evaluate

The experimental variables evaluated were Dependents: Production of tears Independent: Age, Skull type, Right and left eye under study

RESULTS DISCUSSION

Statistical analysis of general tear production

Table 1. General tear production

Tear production in mm/s		
Statistical	**L**eft eye	Right eye
Mean	20,22	21,55
Median	19,00	20,00
Variance	41,59	23,76
Standard deviation	6,45	4,87
Coefficient of variation	31,89%	22,59%
Minimum	8,00	9,00
Maximum	39,00	36,00
Rank	31,00	27,00
Asymmetry	0,34	0,34
Kurtosis	-0,24	-0,03

Of the 394 files that were prepared during the project, 389 presented valid tear production data in both the left eye and the right eye of the sampled animals.

Given that there were variations greater than twenty percent (left eye: 31,89%; right eye: 22,59%) in tear production, the average is better represented by the median, which indicates that the average tear production of the left eye was 19 mm/minute and the tear average of the right eye was 20,00 mm/minute.

According to **Brooks**, (**1992**), a production of 14 to 21,9 mm/min is considered within normal values, tear production of these samples is within normal parameters, it can also be seen that there are significant variations between the production of the left eye to the right.

The relatively large variations were confirmed with the large ranges of tear production with values of 31 mm/minute and 27 mm/minute for the left eye and right eye respectively.

The distributions of tear production in the left eye and right eye of the sampled animals indicate that they present positive asymmetry; that is, there is a greater grouping of the data below the mean for tear production in both eyes. Similarly, tear production in the left eye and right eye show negative kurtosis, identifying a platykurtic shape for the distribution of tear production in the left eye and right eye.

Table 2. Anova, Comparison of tear production between the left eye and the right eye

	Sum of squares	**Df**	**Quadratic mean**	**F**	**Sig.**
Between groups	320,278	1	320,278	9,706	,002
Within groups	25673,076	778	32,999		
Total	25993,354	779			

With a significance level of 5%, significant differences were determined between the tear production of the left eye and the right eye. Verifying the averages, it is identified that the right eye presents greater tear production than the left eye.

Tear Production According To The Shape Of The Skull

An important variable in the classification of tear production was the shape of the skull; Therefore, the mesocephalic, brachycephalic, and dolichocephalic forms were considered.

Table 3. Tear production due to the shape of the skull

	Mesocephalic		**Brachycephalic**		**Dolichocephalic**	
Estadístico	Left eye	Right eye	Left eye	Right eye	Left eye	Right eye
Medium	20,05	21,52	19,29	20,15	22,29	22,93
Median	19,00	20,00	19,00	20,00	22,00	20,00
Variance	41,93	23,21	30,03	19,28	45,21	29,37
Standard deviation	6,48	4,82	5,48	4,39	6,72	5,42
Coeff. of var.	32.31%	22.39%	28.40%	21.78%	30.14%	23.64%
Mínimum	8,00	9,00	8,00	10,00	10,00	15,00
Maximum	39,00	35,00	28,00	28,00	39,00	36,00
Rank	31,00	26,00	20,00	18,00	29,00	21,00
Asymmetry	0,37	0,26	-0,35	-0,15	0,32	0,80
Kurtosis	-0,24	-0,14	-0,22	0,12	-0,57	-0,38

The coefficients of variation of tear production in the left eye and right eye in all skull shapes presented a variation > 20%; Therefore, to analyze the average tear production, the median was considered a reliable statistic.

Regarding the canines considered mesocephalic, the average tear production was 19 mm/minute and 20 mm/minute for the left eye and right eye respectively.

The asymmetries indicate that the distribution of tear production is positive in both the left and right eyes, determining a greater accumulation of data below the average. Negative kurtosis indicates the platicúrtic shape of the left eye and right eye tear production distributions. Regarding the canines considered brachycephalic, as in the mesocephalic, the average tear production was 19 mm/minute and 20 mm / minute for the left eye and right eye respectively.

The asymmetries indicate that the distribution of tear production is negative in both the left and right eyes, determining a greater accumulation of data above the average.

The kurtosis of the left eye indicates a platykurtic form of the tear production data; while the kurtosis of the right eye indicates a leptokurtic form of the tear production data.

Regarding the canines considered dolichocephalic, the average tear production was 22 mm/minute and 20 mm/minute for the left eye and right eye respectively. The asymmetries indicate that the distribution of tear production is positive in both the left and right eyes, determining a greater accumulation of data below the average. Negative kurtosis indicates the platicúrtic shape of the left eye and right eye tear production distributions.

It should be noted that in the province of Bolivar, as there are different types of climatic floors, in the taking of samples, especially of the dogs considered dolichocephalic, they are in constant contact with the changing weather conditions, being able to notice a greater tear production.

Once a descriptive analysis of tear production by type of skull of the studied canines had been carried out, they were compared with each other by production in the left eye and right eye.

Table 4. Normality tests according shape of the skull

Skull shape		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	**Df**	**Sig.**	**Statistic**	**Df**	**Sig.**
Mesocephalic	Tear production of the left eye	,105	314	,000	,979	314	,000
	Lacrimal production right eye	,175	314	,000	,967	314	,000
Brachycephalic	Tear production of the left eye	,079	34	,200*	,955	34	,172
	Lacrimal production right eye	,160	34	,027	,954	34	,160
Dolichocephalic	Tear production of the left eye	,168	41	,005	,953	41	,091
	Lacrimal production right eye	,242	41	,000	,895	41	,001

Considering the Kolmogorov-Smirnov test, with 95% confidence, the distributions of tear production in the left eye and right eye in the three skull shapes determined a normal distribution of the same.

Table 5. Anova, Comparison of tear production of the left eye by skull shape

	Sum of squares	**Df**	**Quadratic mean**	**F**	**Sig.**
Between groups	208,133	2	104,067	2,486	,085
Within groups	16244,670	388	41,868		
Total	16452,803	390			

With a significance level of 5%, it was determined that there were no significant differences between the tear production of the left eye by skull shape; that is, the averages of tear production in the left eye between mesocephalic, brachycephalic, and dolichocephalic are statistically equal.

Table 6. Anova, Comparison of tear production of the right eye by skull shape

	Sum of squares	**Df**	**Quadratic mean**	**F**	**Sig.**
Between groups	144,883	2	72,442	3,081	,05
Within groups	9075,389	386	23,511		
Total	9220,272	388			

With a significance level of 5%, it was determined that there are significant differences between the tear production of the right eye by skull shape, which is perceived with slight variations in the tear production averages in the right eye by skull shape.

Tear Production According To Age Group

The age group was another classification variable for tear production, considering the categories: puppies, adults and manager.

Table 7. Tear production by age group

	Puppy		**Adult**		**Geronte**	
Estatistic	Left eye	Right eye	Left eye	Right eye	Left eye	Right eye
Medium	19,24	19,76	21,21	22,72	18,00	22,32

Median	18,00	19,00	21,00	22,00	18,00	22,00
Variance	41,53	17,97	38,89	23,89	48,42	27,56
Standard deviation	6,44	4,24	6,24	4,89	6,96	5,25
CV	33.47%	21.45%	29.42%	21.52%	38.66%	23.52%
Minimum	8,00	10,00	8,00	9,00	8,00	12,00
Maximum	39,00	35,00	36,00	36,00	33,00	30,00
Rank	31,00	25,00	28,00	27,00	25,00	18,00
Asymmetry	0,67	0,60	0,11	0,16	0,71	-0,01
Kurtosis	0,71	1,34	-0,60	-0,15	0,10	-0,93

The coefficients of variation of tear production for the left eye and the right eye in all age groups presented a variation of more than twenty percent; Therefore, to analyze the average tear production, the median was considered a reliable statistic.

Regarding the canines considered puppies, the average tear production was 18 mm/minute and 19 mm/minute for the left eye and right eye respectively.

The asymmetries indicate that the distribution of tear production is positive in both the left and right eyes, determining a greater accumulation of data below the average. Positive kurtosis indicates a leptokurtic form for the left eye and right eye tear production distributions.

Regarding the canines considered adults, the average tear production was 21 mm/minute and 22 mm/minute from the left and right eyes, respectively. The asymmetries indicate that the distribution of tear production is positive in both the left and right eyes, determining a greater accumulation of data below the average.

Negative kurtosis indicates a flat shape for the left eye and right eye tear production distributions.

Regarding the canines considered elderly, the average tear production was 18 mm/minute and 22 mm/minute for the left eye and right eye respectively. The asymmetry in the distribution of tear production for the left eye is positive; while for the right eye it is negative, determining different groupings between the left eye and the right eye.

Highlighting a greater tear production in adults with a slight statistical difference between puppies and older adults. In similar studies, no significant differences were found between age groups. Unlike tear production in humans, it decreases notably after the age of 60 (**Murube, 2002**). According to the study carried out in this investigation, it does not happen in canines. The kurtosis in tear production in the left eye presents a leptokurtic form; while the shape of the right eye is platykurtic.

Once a descriptive analysis of tear production by age group of the canines studied had been carried out, they were compared with each other by production in the left and right eyes.

Table 8. Normality tests according to age group

		Kolmogorov-Smirnov[a]			**Shapiro-Wilk**		
Age group of the dogs		**Statistic**	**Df**	**Sig.**	**Statistic**	**Df**	**Sig.**
Adult	Tear production of the left eye	,085	215	,001	,984	215	,017
	Lacrimal production right eye	,167	215	,000	,964	215	,000
Puppy	Tear production of the left eye	,134	147	,000	,950	147	,000
	Lacrimal production right eye	,198	147	,000	,947	147	,000
Geront e	Tear production of the left eye	,140	25	,200*	,936	25	,118
	Lacrimal production right eye	,151	25	,146	,948	25	,228

Considering the Kolmogorov-Smirnov test, with 95% confidence, the distributions of tear production in the left eye and right eye in the three age groups determined a normal distribution of the same.

Table 9. Anova, Comparison of tear production of the left eye by age group

	Sum of squares	**Df**	**Quadratic mean**	**F**	**Sig.**
Between groups	507,8	2	253,92	6,19	,002
Within groups	15828,4	386	41,01		
Total	16336,2	388			

With a significance level of 5%, it was determined that there were significant differences between the tear production of the left eye by age group; that is, the averages of tear production in the left eye among puppies, adults, and gerentes are statistically different, with greater tear production been observed in adult canines.

Table 10. Anova, Comparison of tear production of the right eye by age group

	Sum of squares	Df	Quadratic mean	F	Sig.
Between groups	780,8	2	390,38	17,85	,000
Within groups	8396,3	384	21,87		
Total	9177,1	386			

With a significance level of 5%, it was determined that there were significant differences between the tear production of the right eye by age group; that is, the averages of tear production in the right eye among puppies, adults, and older adults are statistically different, with less tear production been observed in puppy canines.

CONCLUSIONS

When performing the statistical analysis, there are differences between the tear production of the left and right eyes. Since there were variations of more than twenty percent Regarding the type of skull between mesocephalic and brachycephalic dogs, there is no major difference in tear production. With regard to age, adult dogs presented greater tear production compared to dogs considered puppies.

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