A MORPHOMETRIC STUDY OF THE LACRIMAL GLAND OF THE CAMEL *(CAMELUS DROMEDARIUS)*

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ABSTRACT

A morphometric study is performed on six lacrimal glands of three adult camels (4-10years of age). The mean volume of the right gland is 2.26±0.24 (SD)cm,^{3} whereas the mean volume of the left gland is 2.26±0.20 (SD)cm^3.The glandular tissue of the right gland accounted for about 64.43% of the total volume of the gland, and the connective tissue occupied about 29.40%, whereas the glandular tissue of the left gland accounted for about 64.69% of the total volume of the gland, and the connective tissue occupied about 26.07%.The lower part of the gland has shown large interlobular ducts, whereas the upper part shows large blood vessels. There are no significant differences between the right and left gland in any of the morphometric parameters. These results are discussed in relation to the mechanism of electrolyte-water balance of camel in the desert environment.

INTRODUCTION

The one-humped camel (*Camelus dromedarius*) is bred in the arid, sub-arid, tropical and subtropical regions of Africa and Asia; it has also been introduced into other regions, such as Australia. In mammals, the lacrimal fluid cleans and moistens the anterior part of the eyeball; its excess moistens the nasal mucosa. The lacrimal gland, in most domestic mammals is compound tubuloalveolar in structure with clusters of secretory end-pieces arranged in tubules (Burkitt, Young and Heath, 1999; Bacha and Bacha, 2000). The septa which divide the gland into lobules of different shapes and sizes come from a connective tissue capsule that surrounds the gland. A review of the literature reveals little about the morphometry of the lacrimal gland of domestic mammals. (Fatehel-Bab, Kamel, Selims and Sayed, 1991) described three regions in the Harderian gland of the camel. The first region (87%) is made up of light cells, the second region (15%) is made up of both light and dark cells, and the third region (7%) is made up of dark cells.

MATERIALS AND METHODS

Six lacrimal glands (three right and three left) from three camels were used in this study. The glands were removed immediately after slaughter from apparently healthy adult animals. The samples were collected from Omdurman slaughter house, Khartoum, Sudan. The gland was first exposed by careful dissection of the skin and the periorbita at the dorsolateral part of the eyeball and then removed.

The water displacement technique of Weibel, (1963) was used for the determination of the gland volume. The absolute volume of the gland was calculated as the mean of the measurements. Immediately after the completion of volume measurements, the gland was fixed by immersion in 10% formalin. Each fixed gland was then cut vertically into three parallel slices representing the medial, middle, and lateral regions of the gland. One block (5×2mm) was taken from each slice, giving a total of three blocks for each gland. The blocks were then dehydrated in ascending grades of ethanol, cleared in xylene and embedded in paraffin wax at 60°C. Serial sections, at 7μ thickness, were stained with haematoxylin and eosin (Culling, 1974). One section from each block was selected on the basis of technical quality Weibel (1963). The selected sections were used for morphometric analysis to determine the volume densities (Vv) of the various components of the lacrimal gland. The components studied were: glandular tissue (including intralobular ducts), the connective tissue, the interlobular ducts, the blood vessels, and the nerves. A Zeiss integrating disc, fitted to a ×12.5 eyepiece, was used to analyse the section by the point counting technique (Weibel, 1963; Dunnil, 1968). Each section was analysed field by field, giving a range of 21-35 fields for each section with a x25 microscope objective. The sufficiency of the number of points to count for each component (except the blood vessels, nerves, and interlobular ducts) to keep the standard order at 5% was determined by cumulative mean blot of (Weibel, 1963). The blood vessels, nerves and interlobular ducts did not fall within the scope of the blot, because these components occupied a small volume of the gland.

The absolute volume of the components of the gland were calculated from the volume densities of the components and the total volume (V) of the fresh gland (i.e. absolute volume = VvXV.). As suggested by Weibel (1963) the statistical analysis of the data obtained by the point counting was restricted to the calculation of the mean of its standard deviation.

RESULTS

There is no significant difference between the morphometric results of the right and left lacrimal glands of the camel. The study has revealed that the mean absolute volume (expressed in cm^3) of the fresh right gland is about 2.26 ±0.24 (SD), and that of the left gland had a volume of 2.26 ±0.20 (SD). The results obtained from the analysis of the histological sections by point counting are shown in (Tables 1– 5).

Table (1): Showing the data obtained by point counting of microscopic fields of three histological sections from the right gland of camel No. 2

Section number	Number of fields counted	Number of points falling on				
		Glandular tissue	Connective tissue	Interlobular ducts	Blood vessels	Nerves
1	26	1413	1000	100	75	12
2	34	2971	350	63	12	4
3	25	1299	896	217	76	12
Total	85	5683	2246	380	163	28

Table (2): Showing the data obtained by point counting of fields of three histological sections from the left gland of camel number 3

Section number	Number of fields counted	Number of points falling on				
		Glandular tissue	Connective tissue	Interlobular ducts	Blood vessels	Nerrves
1	27	1595	786	263	47	9
2	23	1988	289	4	17	2
3	29	1641	969	200	62	28
Total	79	5224	2044	467	126	39

Within the lacrimal gland there is no homogeneity in the distribution of the main components in the microscopic fields. For example in one field there are 90 points falling on glandular tissue, 10 points for connective tissue and no points for ducts, blood vessels and nerves. In contrast, another field showed 54 points for connective tissue, 42 points for ducts, 3 points for blood vessels, 1 point for nerves and no points for glandular tissue. The total number of points falling on glandular tissue is about three times as much as that of the connective tissue (Tables1, 2). The number of points falling on blood vessels were always much more than those falling on nerves; the ratio amounts up to five times as much in most fields.

In the right lacrimal gland, the glandular tissue accounted for about 64.43% of the total volume of the gland, and the connective tissue occupied only about 29.40% of the total volume of the gland. The absolute volume is 1.45cm³ for glandular tissue, and 0.65cm³ for connective tissue (Table 3).

Table (3): Showing the volume of fresh gland and the volume densities of the main components in three camels, expressed as mean percentage ± standard deviations. Mean absolute volumes of these components are given in cm³.

Right gland of camel number	Volume of fresh gland	Glandular tissue		Connective tissue		Interlobular ducts		Blood vessels		Nerves	
		%	cm³	%	cm³	%	cm³	%	xcm³	%	cm³
1	2.5	66.85	1.73	26.42	0.68	4.47	11.62	1.91	0.04	0.32	0.008
2	2.2	63.12	1.38	31.79	0.69	3.35	0.07	1.35	0.02	0.36	0.007
3	2.0	63.32	1.26	30.01	0.60	3.00	0.06	3.06	0.06	0.59	0.011
Mean± SD	2.26 ± 0.24	64.43 ± 2.09	1.45	29.40 ± 2.73	0.65	3.60 ± 0.76	3.91	2.10 ± 0.87	0.04	0.42 ± 0.14	0.008

In the left lacrimal gland, the glandular tissue accounted for about 64.89% of the total volume of the gland, and the connective tissue occupied only about 26.07%. The absolute volume is 1.37cm³ for glandular tissue and 0.63cm³ for connective tissue (Table 4).

Table (4): Showing the volume of fresh gland and the volume densities of their main components in three camels expressed as mean percentage and standard deviations. Mean absolute volumes of these components are given in cm³

Left gland of camel number	Volume of fresh gland (cm³)	Glandular tissue		Connective tissue		Interlobular ducts		Blood vessels		Nerves	
		%	cm³	%	cm³	%	cm³	%	cm³	%	cm³
1	2.50	63.05	1.30	27.16	0.94	7.43	0.18	1.91	0.04	0.43	0.010
2	2.20	65.52	1.50	25.20	0.46	7.32	0.16	1.68	0.03	0.26	0.005
3	2.00	66.12	1.32	25.87	0.51	5.91	0.11	1.59	0.03	0.49	0.009
Mean± SD	2.26 ± 0.20	64.89 ± 1.62	1.37	26.07 ± 0.99	0.63	6.88 ± 0.85	0.15	1.72 ± 0.17	0.03	0.39 ± 0.12	0.008

In both the right and left glands, sections taken from the lower parts of the gland are characterized by the presence of large interlobular ducts, whereas sections taken from the upper parts of the gland showed large blood vessels.

A comparison between the volume densities of the main components of the right and left glands is shown in (Table 5).

Table (5): (A summary of Tables 5 and 6): Showing the volume of the main components of the right and left glands and their insignificant differences. Mean absolute volumes of these components are given in cm^3

Site of the gland	Volume of fresh gland	Glandular tissue		Connective tissue		Interlobular ducts		Blood vessels		Nerves	
		%	cm^3	%	cm^3	%	cm^3	%	cm^3	%	cm^3
Right	2.26 ± 0.24	64.43 ± 2.09	1.45	29.40 ± 2.73	0.65	3.60 ± 0.76	3.91	7.10 ± 0.87	0.04	0.42 ± 0.14	0.008
Left	2.26 ± 0.20	64.89 ± 1.62	1.37	26.07 ± 0.99	0.63	6.88 ± 0.85	0.15	1.72 ± 0.17	0.03	0.39 ± 0.12	0.008

DISCUSSION

As far as we know this is the first morphometric study of the lacrimal gland of a domestic mammal.

In the present study the glandular tissue occupies about 64% of the total volume of the gland, whereas the connective tissue occupies about 29% of the volume of the gland. There is no significant difference between the right and left glands in the relative volumes occupied by the above mentioned components.

The bovine lacrimal gland is 6.0-7.0cm long and 3.5cm width; and the equine gland is 5.0cm long and 2.5-3.0cm width (Diesem, 1968; Sisson and Grossman, 1975) which are considerably larger than the gland of the camel that is 4.0cm long and 2.0cm (Awkati and Al-Bagdadi, 1971). This has already been commented on by the latter authors who stated that the lacrimal gland of the camel is less well-developed than that of either the ox or horse. Thus the statement by Sisson and Grossman (1975) that the size of the lacrimal gland is related to animal size may not be universally true.

The relative volume of the glandular tissue is an indicator to the volume of the lacrimal secretion elaborated by the cells of the end-pieces. It is interesting to note that the lacrimal gland of the camel is relatively small. This suggests that the lacrimal gland of camel secretes a small amount of fluid to preserve the water content of the body.

As it is well known that the main function of the mammalian lacrimal fluid is to clean and moisten the anterior part of the eyeball and the nasal mucosa. The latter function is not possible in the camel because of the absence of the puncta lacrimalia (Abdalla, Fahmy. and Arnautovic, 1970; Awkati and Al-Bagdadi, 1971). Therefore, the main function of the lacrimal fluid in the camel is confined to the washing and moistening of the anterior part of the eyeball. This is an important function to an animal like the camel which inhabits dry, hot and sandy land with numerous sand storms.

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