

## GROSS ANATOMY OF THE LACRIMAL GLAND (GL. LACRIMALIS) AND ITS ARTERIAL VASCULARIZATION IN THE FETUS OF ZAVOT-BRED CATTLE

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**Summary:** This study grossly observed in detail the morphology and arterial vascularization of the lacrimal glands (*Glandula lacrimalis*) of the Zavot-bred cattle raised in Kars and its province, and compared the findings with the 10 mature individuals of the same breed and the literature documents. To do that, a number of 15 fetuses at the age of 2-9 months were used in the research. Sex was disregarded since there were no sex-related differences among the materials used. Methodically, colored-latex was injected through the right and left common carotid arteries, followed by dissection. By this study, morphologic nature and arterial vascularization of the gland were observed. The left Lacrimal gland (*Gl. lacrimalis sinister*) was slightly larger than the right one (*Gl. lacrimalis dexter*). The both glands possessed an appendage-like structure lying on the caudo-lateral aspect of the gland and ventral to the eyeball (*Bulbus oculi*). Its parenchyma was in relation directly with that of the body of the gland. The lacrimal artery (*A. lacrimalis*) always originated from the external ophthalmic subbranch (*A. ophthalmica externa*) of the maxillary artery (*A. maxillaris*) was the only vessel responsible for the nourishment of the gland.

**Keywords:** Fetus, lacrimal gland, vascularization.

### Zavot Irkı Sığır Fötüslerinde Gözyaşı Bezinin Makroanatomi ve Arteriyel Vaskularizasyonu

**Özet:** Bu çalışmada Kars ve yöresinde yetiştirilen Zavot ırkı sığır fötüslerinde gözyaşı bezinin makro-anatomi ve arteriyel beslenmesi detaylı olarak incelenmiştir. Bu amaçla 2-9 aylık 15 adet fötüs kullanılmıştır. Elde edilen bulgular aynı ırka ait 10 adet erişkin materyalden elde edilen bulgularla ve literatür verileriyle karşılaştırılmıştır. Bulgularda cinsiyete bağlı önemli bir farklılık elde edilemediğinden bu parametre dikkate alınmamıştır. Damarların takibi için renklendirilmiş lateks, sağ ve sol a. carotis communis yolu ile enjekte edilmiş ve ilgili anatomik yapılar bütün kadavralarda gözlemlenmiştir. Gözlemlerde sol gözyaşı bezinin daha büyük olduğu saptanmış olup, iki taraftaki bezin de arka yan tarafında fazladan bir uzantıya sahip olduğu belirlenmiştir. Bu uzantının ise bağ doku aracılığıyla bezin gövde kısmına bağlandığı görülmüştür. Bezin beslenmesi ile ilgili olarak a. lacrimalis'in daima a. maxillaris'ten ayrılan a. ophthalmica externa'dan başlangıç aldığı ve bezin beslenmesinden sorumlu tek damar olduğu belirlenmiştir.

**Anahtar sözcükler:** Fötüs, gözyaşı bezi, vaskularizasyon.

## INTRODUCTION

The lacrimal gland is present in mammals in the glandular lacrimal fossa (*Fossa glandulae lacrimalis*) under the zygomatic process (*Processus zygomaticus*) of the frontal bone (*Os frontale*), and dorso-lateral surface of the eyeball<sup>1-5</sup>. It is oval, brown in color, and encapsulated by the periorbital connective tissue<sup>3,6</sup>. The gland in ruminants is composed of two distinct and separate components connected by connective tissue<sup>7</sup>.

The lacrimal gland, embryologically, develops from the ectoderm of the conjunctiva in multiple budding and later these parts migrate to where the gland is found in adults<sup>8</sup>. This migration sometimes is interrupted and results in different pathologic conditions<sup>9,10</sup>.

Even though morphology and vascularization of the lacrimal gland are superficially documented<sup>3,11-14</sup>, gross

anatomical knowledge in detail is not particularly reported. Studies in human being, however, have indicated systematic details on the origin of the lacrimal artery; that are, type I arising from the ophthalmic, type II leaving the external carotid, and type III originating from either the ophthalmic or the middle meningeal, arteries<sup>15-17</sup>. Such systematic details have not been reported on animals so far.

This study has, furthermore, been conducted to observe in detail the morphology and arterial vascularization of the lacrimal glands of the Zavot-bred cattle raised in Kars and its province, to compare the findings with the adult individuals of the same breed and the literature documents, and to make a valuable contribution to the veterinary gross anatomy literature.

## MATERIALS and METHODS

Fetuses were obtained from a local slaughterhouse in

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Kars, a city located in Eastern Anatolia, and ages of the fetuses were defined by the use of the method of Richardson et al. 1990<sup>18</sup>, in which they predicted the age of the fetus by examining the crown-hump length as well as by looking at the bodyweight. The results of the study, carried out according to this method, showed that the age of the fetuses ranged from 2 to 9 months.

Methodically, first of all, thoracic cavities of 15 fetuses were opened and all the arteries, particularly those supplying the head were washed with 0.9 % saline via the left ventricle of the heart. Secondly, the colored-latex (ZPK-582-G produced by Educational & Scientific Products Ltd., Rustington, West Sussex) was injected through both the right and left common carotid arteries. The fetuses, then, were put in 10% formaldehyde fixative solution for polymerization for 48 hours. Finally, dissection was performed, the lacrimal gland and related vessels were documented.

Heads of the 10 adult animals were also acquired from the same slaughterhouse and similar methods were used to observe the lacrimal glands.

Nomina Anatomica Veterinaria, 1994<sup>19</sup> was employed for the anatomical nomenclature.

## RESULTS

The lacrimal gland (Fig. 1/1) in Zavot fetuses was present dorso-lateral to the eyeball, in the glandular lacrimal fossa under the zygomatic process of the frontal bone. It was oval, lobular in shape, brown in color, and encircled by connective and lipid tissues. The gland possessed two distinct features, a body (*Corpus glandulae lacrimalis*) (Fig. 1/2) and an appendage-like component (*Cauda glandulae lacrimalis*) (Fig. 1/3) lying caudo-ventral to the corpus. This was simply a continuation of the corpus. In other words, there was clearly no paranchymal tissue between the two parts, separating them.

The body of the gland was concave on the orbital surface while its appendage-like component was flattened as descending at dorso-ventral direction through the ventral aspect of the eyeball. The medio-lateral length of the body of the left lacrimal gland was 7.62-17.62 mm, while its cranio-caudal length was 16.33-23.19 mm. Likewise, the length of its appendage-like component was 14.96-15.73 mm while the width of that in the midway was 5.72-10.94 mm. Measurements for the same features on the right lacrimal gland were 7.58-15.48, 16.21-22.28, 9.13-15.57, and 4.99-10.78 mm, respectively. The numerical data presented above are the mean values of

the 7 month-fetuses.

A number of 5-7 tear ducts (*Ductuli excretorii*) present between the body of the gland and superior conjunctival fornix (*Fornix conjunctivae superior*) were observed even though the appendage-like component possessed no duct.

The main arterial source of the both lacrimal glands was the maxillary artery (Fig. 1/4). This artery gave, at the level of the eyeball, the origin of the rostral epidural rete (*Rete mirabile epidurale rostrale*) (Fig. 1/5), then the external ophthalmic artery (Fig. 1/6), and then the malar artery (*A. malaris*) (Fig. 1/7). The lacrimal artery (Fig. 1/8) arising always from the external ophthalmic artery advanced, with the lacrimal nerve (*N. lacrimalis*), between the lateral (*M. rectus bulbi lateralis*) (Fig. 1/9) and dorsal (*M. rectus bulbi dorsalis*) (Fig. 1/10) rectus bulbi muscles through the body of the gland. The artery thereby divided into two roughly equal branches, and terminated in the body of the gland.

The appendage-like component of the gland received no particular externally seen vessel. It was supplied by very thin branches coming intraparenchymatously from the body of the gland.

Location and morphology of the gland in the adult individuals of the same breed were similar to the findings of the fetus, with relatively short appendage-like structure.

## DISCUSSION

Several textbooks<sup>2,3,7</sup> have superficially documented the morphology and vascularization of the lacrimal gland in ruminants. They have mentioned that the gland comprises two separate parts attached by a distinct connective tissue, a thick main component namely superior lacrimal gland (*Gl lacrimalis superior*) and a thin one called inferior lacrimal gland (*Gl lacrimalis inferior*). In this study, however, we observed in the fetuses of the Zavot-bred cattle that even though there present two different parts, one a body "*Corpus (glandulae lacrimalis)*" and the other "*Cauda (glandulae lacrimalis)*" they were not separate. The "*cauda*" was simply the continuation of the "*corpus*" of the gland. These names, not mentioned in the Nomina, are specifically used by us to provide clear understanding.

Studies<sup>8,10</sup> have indicated that the lacrimal gland, embryologically, forms from the ectoderm of the conjunctiva in multiple budding and later these parts migrate to where the gland is found in adults. The two parts indicated in the literature<sup>3,7</sup> and in our findings might be because of this migration. While these components

were documented to be attached by a distinct connective tissue, there was no such structure between the two parts in this study. The variation in the attachment of the two parts between what have been reported in the literature and in the Zavot-bred cattle observed in this study may be, again, a difference in the migration.

The numerical data of the 7 month-fetuses were presented hereby. Those which had been taken from the adult individuals were not reported here since they were, naturally, significantly bigger as compared to those of the 7 month-fetuses.

Studies<sup>15-17</sup> systematically classified the origins of the lacrimal gland in human being as type I, II, and III. In type I, the lacrimal artery originates from the ophthalmic artery. Type II lacrimal artery ascends from the external carotid artery. Type III arises from either the ophthalmic or the median meningeal arteries. We also aimed at classifying the lacrimal artery of the fetuses of the Zavot-bred cattle, We have not seen this kind of classification of the lacrimal artery in any animal, like this. We, however, observed that the lacrimal arteries in the fetuses of the Zavot-bred cattle used in this study always arose from the external ophthalmic artery, which is in parallel with the type I vascularization in human being. This study might be beginning of an attempt to classify the arterial vessels supplying the lacrimal gland in animals, and will surely be helpful for this kind of systematic studies on animals.

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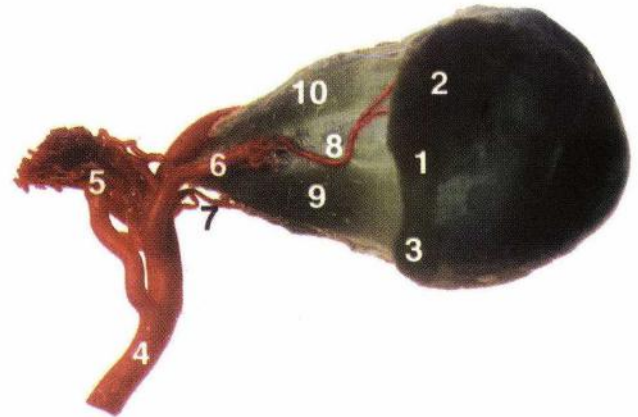
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**Figure 1.** The lacrimal gland and its vascularization in the Fetus of Zavot-Bred Cattle, X2.

1-Lacrimal gland, 2-body of the lacrimal gland, 3-appendage-like component of the lacrimal gland, 4-maxillary artery, 5-origin of the rostral epidural rete, 6-external ophthalmic artery, 7-malar artery, 8-lacrimal artery, 9-lateral rectus bulbi muscle, 10-dorsal rectus bulbi muscle.

**Resim 1.** Zavot ırkı sığır fütüslerinde gözyaşı bezi ve arteriyel vaskularizasyonu, X2.

1- Gözyaşı bezi, 2-gözyaşı bezinin gövdesi, 3- gözyaşı bezinin uzantısı, 4. a. maxillaris, 5-rete epidurale rostrale'nin orijini, 6-a. ophthalmica externa, 7-a. malaris, 8-a. lacrimalis, 9.m. rectus bulbi lateralis, 10-m. rectus bulbi dorsalis.