

Some Morphological Studies on the Lacrimal gland in sheep (*Ovis aries*)

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ABSTRACT

The Glandula lacrimalis of sheep is situated on the dorsolateral aspect of the eye ball. It is flattened and elongated oval in shape and pink to light brown in color. It has two surfaces, two border and two extremities. It was divided into two lobes, large cranial orbital lobe and small accessory caudal palpebral one. The two lobes are connected with each other by connective tissue. The lacrimal gland is supplied by A.lacrimalis of A. temporalis superficialis and A.lacrimalis profunda of rete mirabile a.opthalmica. The venous blood of the lacrimal gland is drained by the V.lacrimalis which detached from the venous ophthalmic plexus. The lacrimal gland is innervated by N.lacrimalis which is a branch of N.opthalmicus of N. trigeminus. The structures of the lacrimal gland included; stroma and parenchyma. The stroma sent many septa that divide the gland to many lobes and lobules via the interlobar and interlobular septa. The parenchymatous tissue was represented by the compacted secretory end pieces and duct system. By scanning electron microscope, the external surface of the gland was consisted of variable sized lobules which connected with each other via irregular rough connective tissue.

INTRODUCTION

The aqueous layer is the major component of the tear film and is produced by the lacrimal gland for normal eye physiology. The tear film prevents the cornea and the conjunctiva from drying, removal of debris from the corneal surface, and prevention of bacterial and viral infections. (1-9).

In sheep (10) mentioned that, the lacrimal gland is flattened and oval in shape, it has a pink color and surrounded by periorbital tissue and the periosteum on the inner surface of the supraorbital portion of the frontal bone. The gland is situated to a great extent under the frontal and overlaps the dorsal rectus muscle. In sheep and goat (12), in goat (11) In Ewasi sheep and black goat (13) and In Lori sheep (14) clarified that, the dorsal lacrimal glands are situated at dorso-lateral surface of eye and undifferentiated in lobulation. (11) added that, the gland is light brown in colour possess two distinct parts, a body and appendage-like part; that has the continuation

of the body. In sheep and goat, (10,12) mentioned that, two large and four to five small excretory ducts originates from the central surface of lacrimal gland. In yak (15-16) celebrated that, the external ophthalmic artery gives branches to supply the lacrimal gland and to take part in the formation of the ophthalmic rete mirabile. The superficial temporal artery detached off some branches to supply the lacrimal gland and anastomosed with the lacrimal artery of the ophthalmic rete mirabile.

In Lori sheep (14) noticed that the lacrimal gland is a mixed gland consisting of tubulo-acinar units. Both types of serous and mucous acini are observed. The surrounding connective tissue penetrates into the gland and divides its parenchyma into several lobules. This separating connective tissue is rich in blood vessels and possesses excretory ducts.

The aim of this work to clarify the macroscopic structures of the lacrimal gland, its arterial supply, venous drainage and nerve

supply, as well as microscopic and scanning electron microscope of *Ovis aries* sheep.

are used as outline by (19,20). For Scanning electron microscopy (SEM) examination two fresh head sheep were used according (21), Then examined with JSM-35 scanning electron microscope (JEOL CO.USA) at 25KV, accelerating voltage, at the Faculty of Medicine, Tanta University.

MATERIAL AND METHODS

The current work was carried out on 17 heads of apparently healthy sheep of both sexes with variable ages. The heads were collected from Zagazig and Belbes slaughter houses. For topographical morphology five heads were freshly dissected after slaughter the animals for study of the position, color and shape of the lacrimal glands and the excretory ducts. Measurements by using stainless Caliper and flexible meter were carried on five animals which used in the topographical morphology, then Statistical analysis to the results, for the study of the dimensions of the glands. Computed Tomography (CT) of fresh two sheep heads was selected. For the study of the blood supply of the lacrimal gland, four fresh heads were used. The heads were perfused firstly with normal saline through the right and left common carotid arteries according to (17). Then two heads were injected by gum milk (Latex 60%) colored red with scib paint. The other two heads were injected gently with gum milk (Latex 60%) colored blue with scib paint through the lingofacial vein. The heads were preserved in 10% formalin solution for 4-7 days. For the study of nerve supply of the lacrimal gland two fresh sheep heads were used. The heads were immersed in a mixture of 10% formalin, 3% glycerine; 1% thymol then will dissect for detection of nerve supply of lacrimal glands. Along the course of this work the nomenclature used was those adopted by (18), as if it was possible. For light microscopic examination, two fresh head sheep were used. The glands were isolated, processed and stained with *Harris haematoxylin and eosin* (H&E), *Alcian Blue*- (2.5), *Periodic Acid Schiff* (PAS) and *Crossmon's trichrome stain*. The previous methods of processing and staining

RESULTS

Glandula lacrimalis of sheep is situated within special division of the periorbita on the dorsolateral aspect of the eye ball. The gland is bounded dorsolaterally by the zygomatic process of the frontal bone and ventrally by the inner layer of the periorbita, the aponeurosis of the levator palpebrae superioris, superior obliques and external rectus muscles (Figs.1, 2 & 3). It was flattened and elongated oval in shape with irregular rostral edges. It is pink in color in fresh state and light brown in formalized specimens. Glandula lacrimalis was curved in conformity with related structure, had two surfaces, two border and two extremities. It is divided into two lobes; large main cranial orbital lobe and small accessory caudal palpebral lobe. The two lobes connected with each other by connective tissue band (Fig.4). The average length of main portion of the gland were measure about 3.36 ± 0.15 cm at antero-posterior direction and the accessory portion measure about 1 ± 0.12 . The average width of main portion measure about 2.46 ± 0.21 cm at medio-lateral direction and the accessory portion measure about 0.76 ± 0.10 . The average measurements of the gland were illustrated in (table 1 & chart 1).

The gland were possessed two large and two small excretory ducts emerged from the ventral surface of the gland and ran parallel to each other, penetrated the periorbita and opened at the dorsal fornix of conjunctiva (Fig. 5&6). A.lacrimalis originated from the A.temporalis superficialis artery and extended

rostrally crossing the temporal condyle till reach the lacrimal gland (Fig. 7). A.lacrimalis profunda originated from rete mirabile a.opthalmica. It arose from the cranial aspect of rete mirabile a.opthalmica and ascends rostrally between the muscle dorsal rectus and lateral rectus together with homologues vein and nerve (Fig. 8). Finally the A.lacrimalis of A.temporalis superficialis anastomosed with A.lacrimalis profunda of the rete mirabile a.opthalmica under the ventral surface of the gland. The venous drainage of the lacrimal gland was drained by V. lacrimalis which originated from the venous ophthalmic plexus. V. lacrimalis were passed rostrally between the muscle lateral rectus and the dorsal one with its homologues artery (Figs. 9&10). It were continued as dorsal external ophthalmic vein which was derived from the superficial temporal vein which obtained from the maxillary vein after separation of the transverse facial vein (Fig. 11). The lacrimal gland was innervated by N. lacrimalis which was a branch of N. ophthalmicus of N.trigeminus. N. lacrimalis crossed with the homologous artery towards the lacrimal gland. It travelled as a single nerve trunk firstly, then divided into three parallel branches; the right, left and middle one near the ventral surface of the gland (Figs. 12&13).

It was observed that the lacrimal gland consisted of stroma and parenchyma. The connective tissue stroma included thin capsule that send many septa divide the gland into many lobes and lobules via the interlobar and interlobular septa, respectively. The

parenchymatous tissue was represented by the compacted secretory end pieces and duct system (Figs. 14,15&16). Both thin capsule and septa were formed mainly from collagen fibers (Fig. 15). The interlobar ducts were associated with longitudinal wavy nerve fiber and lined with stratified cuboidal epithelium (Fig.17). Two different lining epithelia of interlobular ducts were detected. Their narrow lumen was lined with simple cuboidal epithelium. While, wide lumen is lined with double layer of cuboidal cells (Fig. 18).

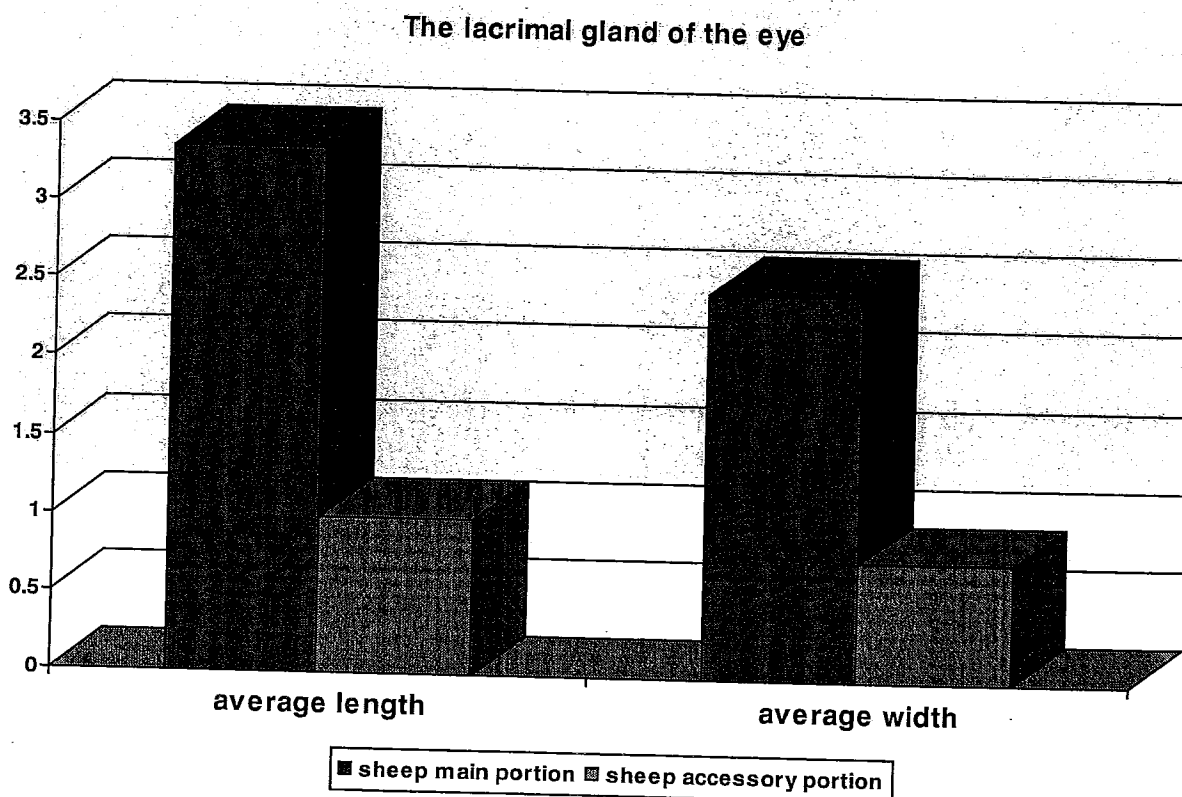
The secretory end pieces were variable shapes; alveolar type with narrow lumen and tubular type with wide lumen. The lining secretory epithelia of these secretory end pieces had basally rounded and dark basophilic nuclei. Their cytoplasm were homogenous eosinophilic (Fig. 19). The secretory end pieces were positively reacted to PAS (Fig. 20). With Ab, three types of negatively, positively and mixed reacted acini were observed (Fig. 21).

By scanning electron microscope, the external surface of the lacrimal gland was consisted of variable sized lobules. The latter connected with each other by irregular rough connective tissue a central and oval interlobular duct. The howl gland surround by thin straight capsule (Fig.22). The lobules were formed from elongated oval to round acini with variable sizes. The acini had a rough porous surface (Figs.23&24). The intralobular duct had a large oval to elliptical opening with two lips (Figs. 24&25).

Table 1. Elucidate the different measurements of lacrimal gland of sheep

| Number of specimens (cm) | Large main cranial orbital lobe | | Small accessory caudal palpebral lobe | |
|-----------------------------|---------------------------------|-------------|---------------------------------------|-------------|
| | The length | The width | The length | The width |
| 1 st | 3.3 | 2.5 | 1 | 0.8 |
| 2 nd | 3.4 | 2.6 | 1.1 | 0.9 |
| 3 rd | 3.4 | 2.5 | 1 | 0.7 |
| 4 th | 3.2 | 2.3 | 0.9 | 0.6 |
| 5 th | 3.5 | 2.4 | 1 | 0.8 |
| Average | 3.36 | 2.46 | 1 | 0.76 |

Chart 1. Elucidate the different measurements of lacrimal gland of sheep.



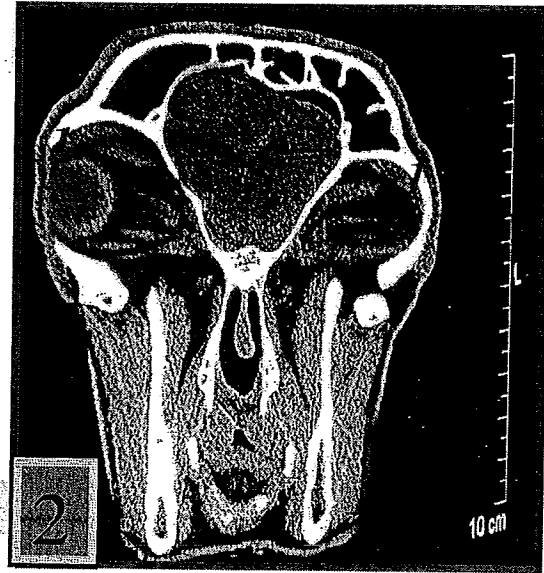


Fig. 1. A photomicrograph of sheep's head (right side) after removed supraorbital process of the frontal bone (dorsolateral view) showing the the zygomatic process of the frontal bone (1), Glandula lacrimalis (2), the medial canthus (3).

Fig. 2. A photomicrograph of the computed tomography (CT) of the normal adult sheep head axial section showing Glandula lacrimalis (1).



Fig. 3. A photomicrograph of sheep's head after removed large part of frontal bone and dorsal covering to the orbit (dorsolateral view) showing the inner layer of the periorbita (1), Glandula lacrimalis (2), M. rectus dorsalis (3), M. rectus lateral (4), M. obliquus dorsalis (5), the aponeurosis M. levator palpebrae superioris (6), The anterior border (blue arrow) and posterior thick border (black arrow).

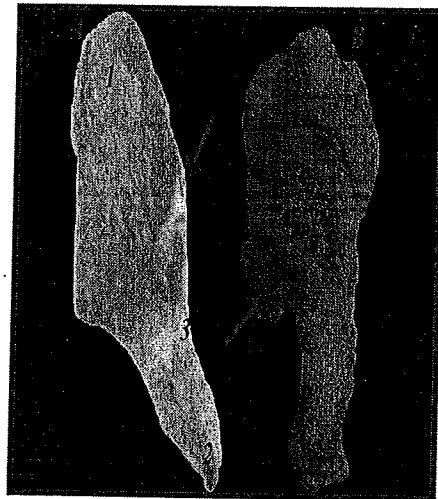


Fig. 4. A photomicrograph of sheep's Glandula lacrimalis showing the flattened and elongated oval pink fresh (A) and the light brown formalized (B) separated Glandula lacrimalis, The anterior border was irregular, thin with caudal deep notch (red arrow), posterior thick border (black arrow), large main cranial orbital lobe (1), small accessory caudal palpebra lobe (2) and the two lobes connected with each other by connective tissue (3).

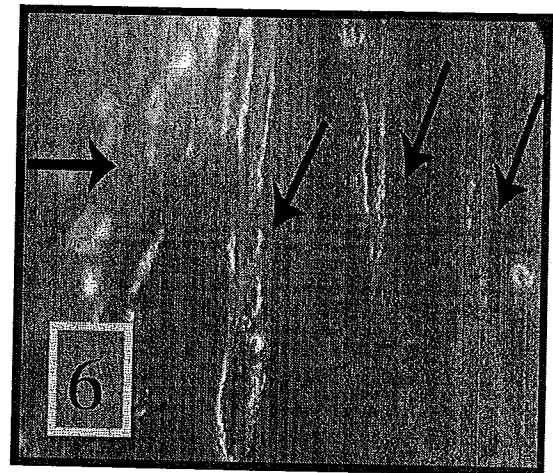
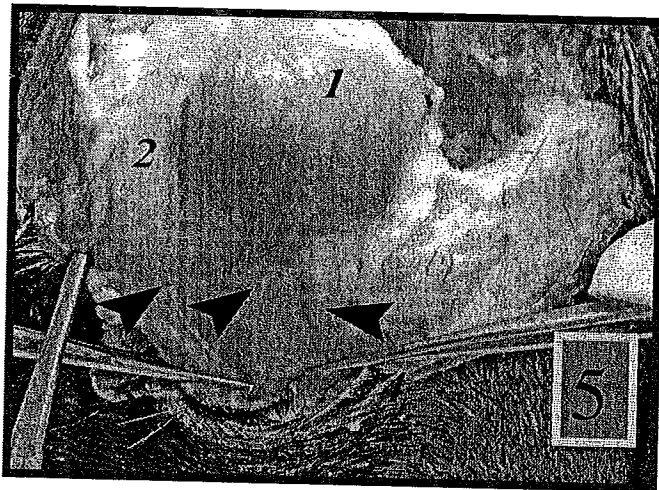


Fig. 5. A photomicrograph of sheep's excretory ducts after removed covering skin and bones to eye (dorsal view) showing the Glandula lacrimalis (1), the inner layer of the periorbita (2), medial canthus of left eye (3), the lateral canthus of left eye (4) and Three excretory ducts ran parallel to each other (arrowheads).

Fig. 6. A photomicrograph of sheep's excretory ducts (stereomicroscope X1,6) showing four excretory ducts ran parallel to each other inner layer of the periorbita (black arrows).



Fig. 7. A photomicrograph of sheep head's(dorsolateral view) injected by gum milk (Latex 60%) colored red with scib paint through the common carotid artery after removed supraorbital process of the frontal bone and part of muscle pytergoid showing of Glandula lacrimalis (1), A. lacrimalis(2), A. temporaisl superficialis (3), and A. carotis externa (4).

Fig. 8. A photomicrograph of sheep's eye (dorsolateral view) separated from head injected by gum milk (Latex 60%) colored red with scib paint through A. carotis communis artery showing of Glandula lacrimalis (1), M. rectus lateralis (2),M. rectus dorsalis (3), A. carotis externa (4), rete mirabile a.ophthalmica (5), A.lacrimalis profunda (6) and M.retractor bulbi (7).



Fig. 9. A photo macrograph of sheep's eye (dorsolateral view) separated from head injected gently with gum milk (Latex 60%) colored blue with scib paint through the V.lingofaciais with removal surround periorbital tissue and dorsal bony boundary of orbital cavity structure and reflection to the lacrimal gland showing the venous ophthalmic plexus (1), V.lacrimalis (2), the reflected lacrimal gland (3), M. rectus lateralis (4), M. rectus dorsalis (5) and homologues artery (6).

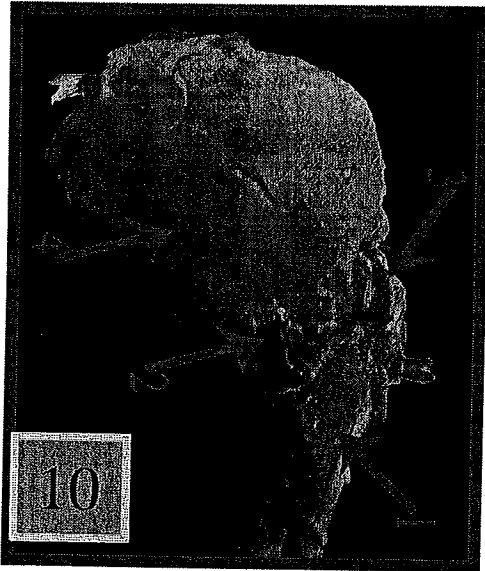


Fig. 10. A photo macrograph of sheep's eye (dorsolateral view) separated from head injected gently with gum milk (Latex 60%) colored blue with scib paint through the V.lingofacialis showing the venous ophthalmic plexus (1), the lateral branch of plexus (2), medial branch of plexus (3) and the lacrimal gland(4).

Fig. 11. A photo macrograph sheep's head injected gently with gum milk (Latex 60%) colored blue with scib paint through the V. Lingofacialis (lateral view) after removal the supraorbital process of frontal bone and exposure to the lacrimal gland showing the dorsal external ophthalmic vein (1), V. lacrimalis (2), the lacrimal gland (3) and M.rectus lateralis (4).

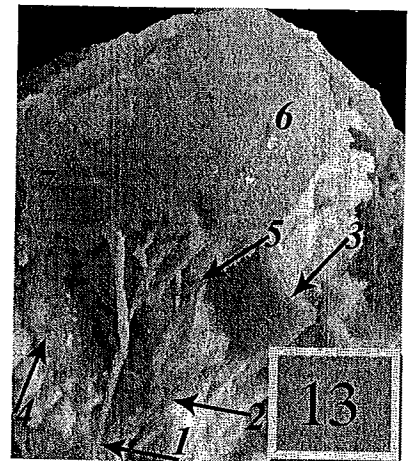


Fig. 12. A photomacrograph of sheep head's (caudodorsal view) after removal the dorsal boundary of the orbit (pterygopalatine fossa) and exposure to the lacrimal gland showing N. trigeminus (1), N.ophthalmicus(2), common trunk for N. lacrimalis and frontalis (3), N. lacrimalis (4), N. frontalis (5), the caudal part of lacrimal gland (6), the olfactory fossa (7),the cerebellum impression (8) and the foramen orbito-rotundum arrow head.

Fig. 13. A photomacrograph of sheep lacrimal gland innervations after removal the dorsal boundary of the orbit (caudodorsal view) showing the N. lacrimalis (1), rete mirabile a.ophthalmica (2), M. rectus dorsalis (reflected) (3),M. rectus lateralis (reflected) (4), A.lacrimalis profunda (5), main part of lacrimal gland (6) and the accessory part lacrimal gland (7).

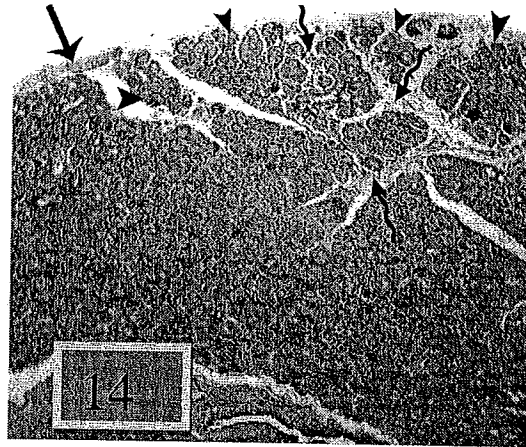


Fig. 14. A photomicrograph of cross section in the sheep's lacrimal gland showing thin capsule "arrow" send many septa "zigzag arrows" that divide gland into many lobules "arrowheads". Stain: H&E Obj. X 4: Oc. X 10

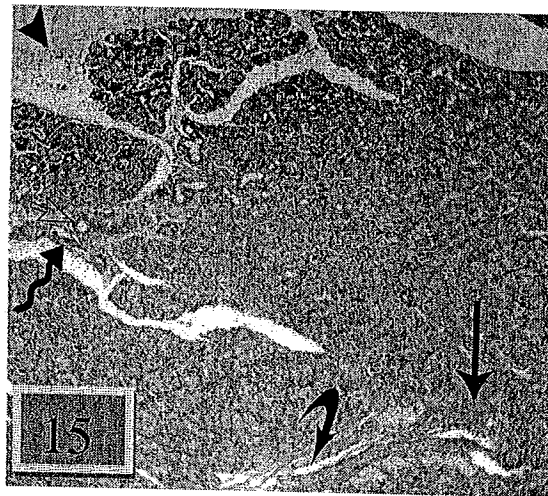


Fig. 15. A photomicrograph of cross section in the sheep's lacrimal gland showing thin capsule "arrowhead", inter lobular septa " zigzag arrow" and interlobar septa " arrow" are formed mainly of collagen fibers. inter lobular " open arrow" and interlobar " closed arrow" ducts are noticed. Stain: Crossman's trichrome Obj. X 4 : Oc. X 10

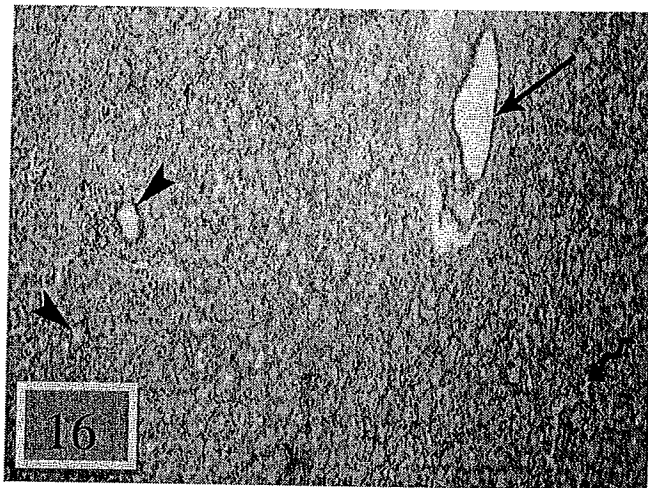


Fig. 16. A photomicrograph of cross section in the sheep's lacrimal gland showing interlobar and interlobular septa carry interlobar duct "arrow" and interlobular duct "arrowheads" respectively. The compacted secretory end pieces "zigzag arrow" are noticed. Stain: H&E Obj. X 4 : Oc. X 10.

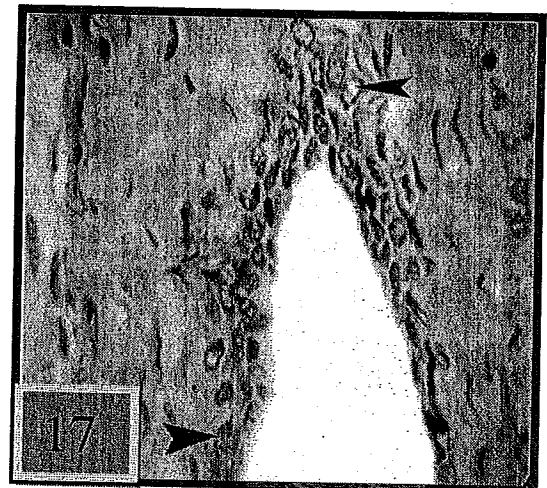
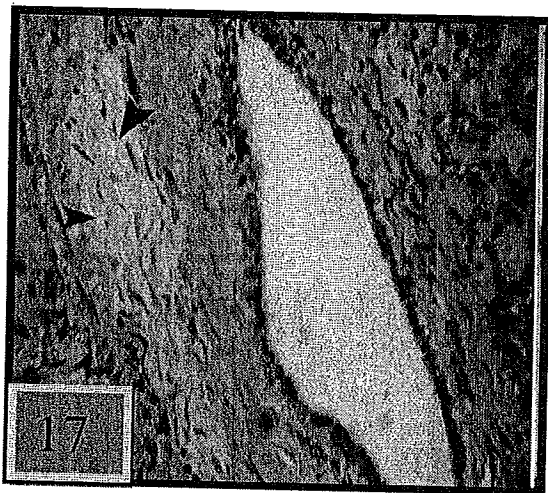


Fig. 17. Higher magnification of the figure (15) A: indicating the duct is associated with longitudinal wavy nerve fiber "arrowhead". B: indicating the interlobular duct are lined with stratified cuboidal epithelium "arrowheads". Stain : A & B: H& E A : Obj. X 40 : Oc. X 10 B : Obj. X 100: Oc. X 10

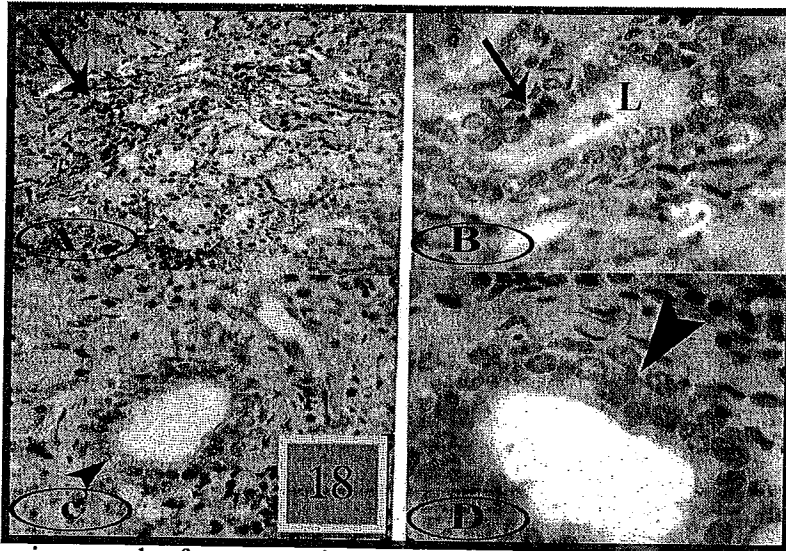


Fig. 18. A photomicrograph of cross section in the sheep's lacrimal gland showing different lining epithelia of interlobular duct **A & B**: indicating the narrow lumen "L" of interlobular duct is lined with simple cuboidal epithelium "arrow". **C&D**: indicating the wide lumen of interlobular duct is lined with double layer of cuboidal cells "arrowheads".
Stain: A, B, C&D: H&E **A & C:** Obj. X 10 : Oc. X 10 **B & D:** Obj. X 100: Oc. X 10

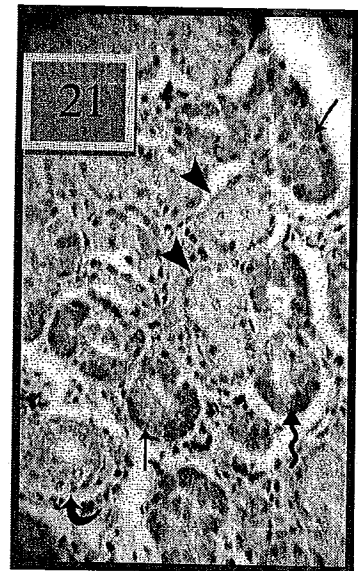
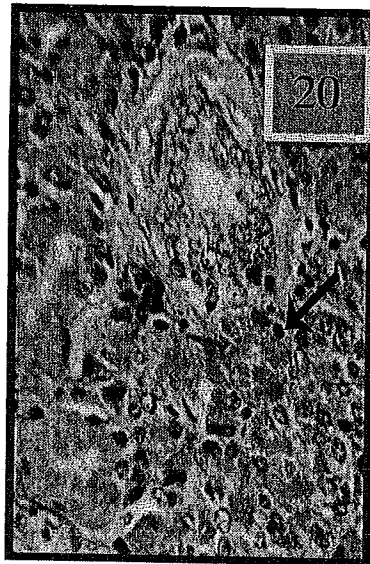
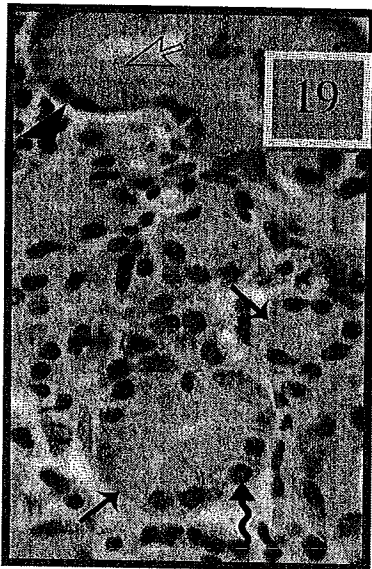


Fig. 19. A photomicrograph of cross section in the sheep's lacrimal gland showing secretory end pieces with variable shapes of alveolar type "arrows" with narrow lumen and tubular "arrowhead" type with wide lumen. The lining secretory epithelia of these secretory end pieces has basally rounded and dark basophilic nuclei "Zigzag arrow". Their cytoplasm is homogenous eosinophilic "opened arrow".
Stain: H&E **Obj. X 100 : Oc. X 10**

Fig. 20. A photomicrograph of cross section in the sheep's lacrimal gland showing the surrounding secretory end pieces are positively reacted to PAS "arrow".
Stain: PAS **Obj. X 40 : Oc. X 10**

Fig. 21. A photomicrograph of cross section in the sheep's lacrimal gland showing secretory end pieces are three types of positively "arrows", negatively "arrowheads" and mixed type "Zigzag arrow" reacted with Ab. The intralobular duct is negatively reacted with Ab is noticed "closed arrow". **Stain:** A b **Obj. X10: Oc.X10.**

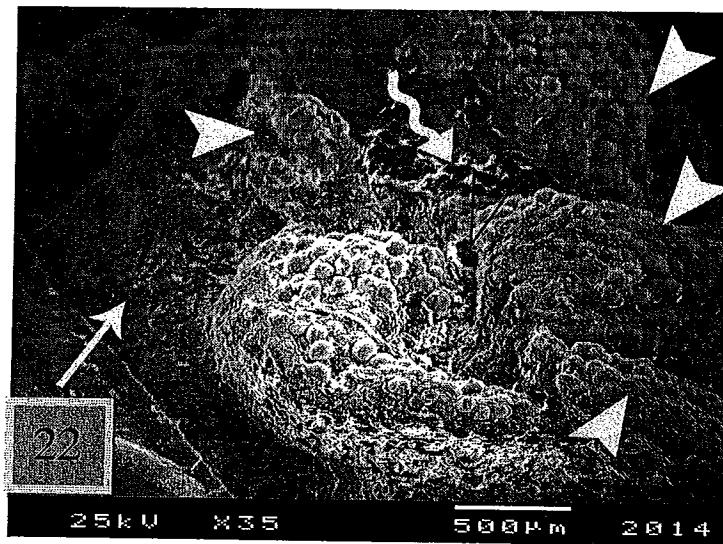


Fig. 22. A photomicrograph of Scanning electron microscope of the sheep lacrimal gland showing variable sized lobules "arrowheads" connected with each other by irregular rough connective tissue "zigzag arrows" and central oval opened interlobular duct "opened arrow" .the howl gland surround by thin c straight capsule "arrow" 35/scale bar: 500 µm.

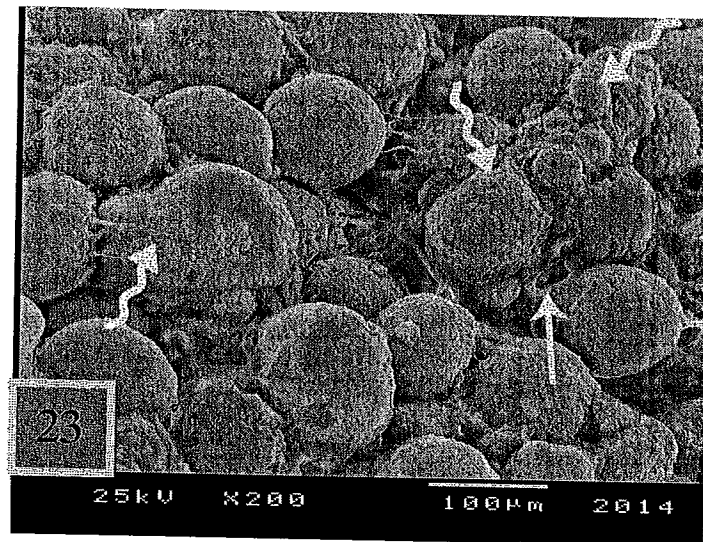


Fig. 23. A photomicrograph of Scanning electron microscope of the one lobule of sheep lacrimal gland showing variable size of elongated oval to round acini "zigzag arrows" with opened elliptical intralobular duct "arrow" 200/scale bar: 100 µm.

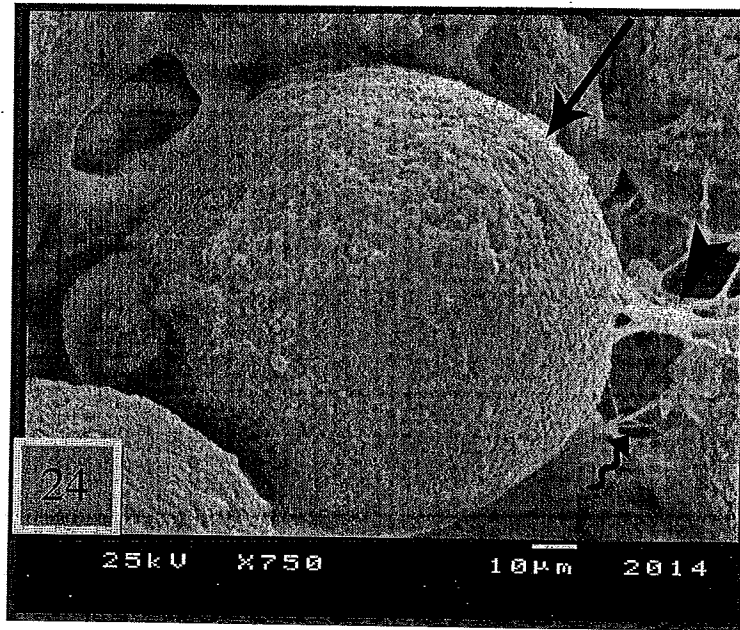


Fig. 24. A photomicrograph of Scanning electron microscope of the one acinus of sheep lacrimal gland lobule showing large round acini with porous rough surface "arrow" while discharging mucus and mineral substance "arrowheads" in oval to elliptical opened intralobular duct "zigzag arrows" 750/scale bar: 10 µm.

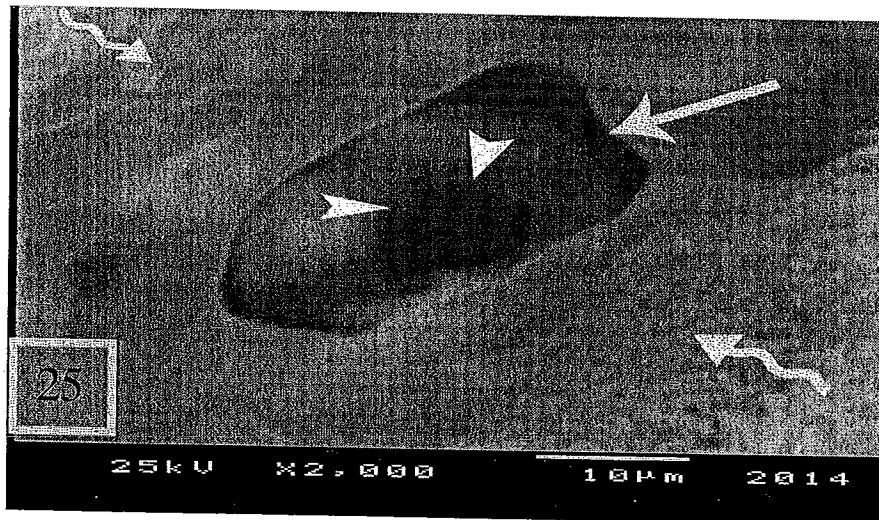


Fig. 25. A photomicrograph of Scanning electron microscope of the interlobular duct of sheep lacrimal gland showing large elliptical opening of duct which have two lips "arrow" with internal rounded open "arrowheads" surrounded by rough porous acinar surface "zigzag arrows" 2000/scale bar: 10 µm.

DISCUSSION

The present study revealed that, the lacrimal gland is situated on the dorsolateral aspect of eye ball. These results were simulated the results of (14) in Lori sheep; (20) in Roe Deer; (13) in Ewasi sheep and black goat; (11) in goat; (12) in sheep and goat; (11) in donkey; (21) in the Philippine water buffalo; (22) and (23). This work confirmed that, the gland was bounded dorsolaterally by the zygomatic process of the frontal bone. It was attached ventrally by the inner layer of the periorbita, the aponeurosis of the levator palpebrae superioris, superior obliques and dorsal rectus muscles. These finding are similar to those described in donkey, (11) and in cattle and sheep (10,23). Concerning to the shape and color the lacrimal gland of sheep, it was flattened and elongated oval in shape with irregular rostral edges. It was pink to light brown in color in fresh and formalized specimen respectively. These results were agreement with (13), in Ewasi sheep and black goat; (11) in goat and camel. According to our findings the lacrimal gland in sheep was curved in conformity with related structure, had two surfaces both surfaces appeared lobulated with marbling appearance. These results were in harmony with that mentioned in camel by (24). The current study showed that the lacrimal gland in sheep was divided into two lobes; large main cranial orbital lobe and small accessory caudal palpebral one. The two lobes connected with each other by connective tissue. This results partially go on hand with (11), in goat who reported that, the gland is possess two distinct parts, a body and appendage-like part; this has the continuation of the body.

Our finding confirmed that, the lacrimal artery originated from the superficial temporal artery and the deep lacrimal artery originated from of the ophthalmic rete mirabile. These result go in hand with (15-16) in yak. The current work showed that, the lacrimal veins which originated from the venous ophthalmic plexus. These results were agree with (27) in bovine. Our work established nerve supply of lacrimal gland was innervated by lacrimal

nerve which was a branch of ophthalmic of trigeminal nerve. These results were in harmony with that mention in dog by (28).

Our work observed that, the lacrimal gland consists of stroma and parenchyma . Stroma included thin capsule that send many septa that divide the gland into many lobes and lobules via the interlobar and interlobular septa. The parenchymatous tissue was represented by the compacted secretory end pieces and duct system. The pervious finding agreement with mention by (14) in lori sheep.

Concerning to scanning electron microscope, the external surface of the gland consistsof variable sized lobules which connected with each other by irregular rough connective tissue a central and oval interlobular duct.

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الملخص العربي

بعض الدراسات المورفولوجية على الغدة الدمعية في الأغنام

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أظهرت الدراسات المورفولوجية أن الغدة الدمعية للأغنام تقع ضمن قسم خاص للبريوربيتا على الجانب الظهراني من كرة العين. وهي بيضاوية الشكل وممدودة وتأخذ اللون الوردي إلى البني الفاتح. ولها سطحين، وحدين وطرافين. تم تقسيم الغدة إلى فصين: فص مداري كبير رئيسي أمامي وآخر جفني صغير ذيلي والفصوص متصلة مع بعضها البعض من خلال النسيج الضام. وقد أثبتت النتائج أن الغدة الدمعية تستقبل الامداد الدموي من خلال الشريان الدمعي والشريان الدمعي العميق. وهكذا الدم الوريدي للغدة الدمعية يتم عن طريق الوريد الدمعي. أما المدد العصبي يكون عن طريق العصب الدمعي من العصب مثلث التوائم. ولوحظ أن الغدة الدمعية تتكون من سدى وحمة. ويشمل السدى كبسولة رقيقة التي ترسل العديد من الحواجز التي تقسم الغدة إلى العديد من الفصوص والفصيصات عبر الفصوص والحاجز بين الفصين. وعن طريق الماسح الضوئي للمجهر الالكتروني وجد أن السطح الخارجي للغدة يتألف من فصيصات متغيرة الحجم التي ترتبط مع بعضها البعض من خلال النسيج الضام التي يوجد به القنوات البيضاوية وغير المنتظمة.