

**ORIGINAL CONTRIBUTIONS
CONCERNING THE GLANDULAR
STRUCTURES APPERTAINING TO
THE HUMAN EYE AND ITS
APPENDAGES**

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Original Contributions Concerning the Glandular Structures Appertaining to the Human Eye
and Its Appendages by Adolf Alt

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THE HUMAN EYE AND ITS APPENDAGES.*

ADOLF ALT, M. D.

PREFACE.

The studies and investigations which are the subject of this paper are the outcome of a desire to have as clear as possible an understanding of the glandular structures appertaining to the human eye and its appendages from personal knowledge.

It took a number of years to accumulate the very numerous specimens, the careful study of which furnished the basis for the descriptions here given. While part of the many eyelids which I have examined were obtained from suitable cases in my own practice, a large number came from the dissecting rooms of the Beaumont Hospital Medical College of this city through the kindness of Dr. R. W. Baker, the demonstrator of anatomy in this institution. Of necessity a great part of this anatomical material was of a pathological character, and it has, therefore, served for other studies as well.

As it seemed to me that the text-books which I know of, with but few exceptions, deal in a very insufficient manner with this interesting subject, I have thought it might be of some interest to place the results of my own investigations in this direction before the ophthalmic public. This may, perhaps, prove the more interesting, since by the efforts of numerous foreign ophthalmic surgeons, and in this country notably of Dr. C. R. Holmes of Cincinnati † the old operation of the removal of the lacrymal glands for incurable lacryma-

* Presented by title to The Academy of Science of St. Louis, May 21, 1900.

† Archives of Ophthalmology, 28:1.

tion has of late been reintroduced and has become a legitimate surgical procedure.

The investigations herein recorded may claim to be original in so far as they were made, in a sense, as if I had known nothing of the literature on the subject. This was in reality the case with some of the more recent monographs which I did not and had no chance to consult until my researches, at least as far as my material would allow me, were finished.

The illustrations, except the three last ones, which are more or less schematic drawings, are made from photographs I took of my own specimens.

THE ORBITAL, PALPEBRAL AND CONJUNCTIVAL LACRYMAL GLANDS.

The lacrymal gland is usually spoken of as consisting of two separate parts, one the so-called orbital lacrymal gland and the other termed the inferior, palpebral, conjunctival or accessory lacrymal gland.

The orbital lacrymal gland, as its name denotes, is situated, at least to its greatest extent, within the orbital cavity. There it is located in the fovea lacrymalis which lies right behind the outer upper bony orbital margin in the processus zygomaticus of the frontal bone. Its anterior end usually slightly protrudes beyond the bony margin. The gland is held in this position by a connective tissue capsule which is united with the orbital periosteum by means of loosely interwoven trabeculae. This capsule is generally somewhat firmer on the nasal side of the gland.

When this gland is in toto removed from the fovea lacrymalis, its shape is seen to resemble to some extent that of an almond (Fig. 1). It is convex at the orbital surface, and more or less concave at its ocular (lower) side. Its posterior portion is usually thick and rounded, its anterior one thinner and sharper. The posterior part of the gland may, when it is well developed, reach back into the orbit about as far as the anterior third of its depth. The nasal edge usually reaches to the temporal margin of the superior rectus muscle.

However, the actual measurements of this gland, like those of other glands, are subject to great variations. As an inter-

esting fact, I may say, that in the Negro I have found this gland to be as a rule larger than in the Caucasian. I have seen it often to be twice as large or even more (Figs. 2, 3).

The orbital lacrymal gland forms a more or less compact glandular body. It consists of a large number of lobules united closely with each other by loose connective tissue in which its ducts and numerous blood vessels lie. These connective tissue trabeculae are united to its capsule.

The gland is of the acinous type and its structure has been correctly likened to that of the serous or salivary glands. The round or oval final acini are situated around and connected with small efferent ducts which, by their union in the direction towards the conjunctiva, form larger and larger excretory ducts. These acini consist of a membrana propria and a lining of cylindrical, or rather, conical secretory epithelial cells, with a large round or oval nucleus near their broader base which are arranged in a circle around a central lumen.

The secretion of this gland is carried to the conjunctival sac by means of a varying number of these excretory ducts which are lined with a cylindrical epithelium. The statement is made by numerous authors, that there are from 6 to 12 such excretory ducts. It does not seem to me that there are so many. I often found one of them, which also seemed to be the longest, to be considerably wider than the others.

These excretory ducts reach the conjunctiva of the fornix by a somewhat bent and wavy course; their external orifices lie in the temporal part of the conjunctival sac near the edge of the tarsal tissue.

Below the orbital lacrymal gland and separated from it by its capsule, the levator palpebrae superioris muscle and Mueller's non-striated muscle, and embedded in the loose connective tissue of the eyelid on the temporal side of the tarsus, lies the inferior or palpebral lacrymal gland (Figs. 1 to 5).

This gland consists of a varying number of smaller and larger lobules which are very much more loosely held together by the intervening connective tissue than those of the orbital gland, and therefore do not form as compact a body.

While this gland is usually thought to lie in the upper eye-

lid alone, I have in normal lids almost invariably found its lobules to reach downwards through and beyond the outer canthus into the lower eyelid (Figs. 6, 7). The glandular lobules here lie grouped around the temporal and sometimes even the lower edge of the tarsus. Similar lobules of glandular tissue, only still more loosely connected with and further apart from each other, are found in most eyelids to extend from the more compact temporal body of this palpebral glandular system towards the nasal side of the upper eyelid. These more isolated lobules may reach to the middle line of the eyelid and even somewhat beyond it (Figs. 8, 9). They lie in the loose tissue of the fornix of the conjunctiva or a little below it on the palpebral side. The farther away from the outer canthus, the smaller these glandular lobules usually are. Those found in the temporal side of the lower eyelid seem to be of a more uniform size. Yet, there is no absolute rule about this.

It seems that when speaking of the palpebral or inferior lacrymal gland, we have to include all of these separate and so widely dispersed glandular lobules. Their number in the aggregate may well reach up to 40 or more.

The structure of the glandular lobules is exactly the same as that of the orbital lacrymal gland. They differ in no particular. Their numerous efferent ducts, lined with cylindrical epithelium, lead their secretion to the conjunctival sac (Fig. 10). The statement has often been made and repeated, that the ducts of these glands are taken up by those of the orbital lacrymal gland around which, in part, they are grouped, before reaching the conjunctival surface. Whether this happens often, I cannot tell definitely in spite of my numerous specimens; but it may occasionally be the case. I find, that most frequently several of these lobules have an excretory duct in common, which runs separately from the excretory ducts of the orbital lacrymal gland to the conjunctiva. Such a duct has generally a wavy course and does not reach the conjunctiva by the shortest route (Figs. 10 to 16). The more widely separated and the totally isolated glandular lobules in the lower eyelid and those glands which extend in the upper eyelid towards its middle line, must of necessity

have their ducts apart from those of the orbital lacrymal gland, as they lie so far removed from them. The external orifices of these ducts lie in the upper conjunctival fornix and usually form a row, being arranged side by side. I may state here, that these excretory ducts pierce the conjunctival surface generally at a more or less acute angle in a downward direction, so that the upper lip overhangs the orifice (Figs. 11, 14).

Even in what appear to be perfectly normal conjunctivae, the orifices of the ducts are frequently surrounded by a dense lymphoid infiltration in the adjoining tissue. This infiltration is frequently so dense that on surface specimens it may hide the openings. This condition may, perhaps, be the explanation for the repeated statements that in the normal conjunctiva of man lymph-follicles could be found. I here repeat the statement which I have made on other occasions, that, like Waldeyer, I have never found a true lymph-follicle in the human conjunctiva.

From the foregoing description it is apparent that a very large, though varying, amount of glandular tissue, of identically the same structure and most probably the same function as the orbital lacrymal gland, is situated in the temporal half of the eyelids above, respectively below, the fornix conjunctivae. The secretion of all of these glands, combined with that of the orbital lacrymal gland, is discharged into the conjunctival sac and, flowing over the surface of the eyeball, keeps it and the inner surfaces of the eyelids moist.

Yet, even a careful removal of all of this glandular tissue does not render the surface of the eyeball dry. There must, therefore, be still other glandular structures, which supply such a moistening liquid, and, in reality, a number of such glands do exist.

Almost without exception I find one such gland, consisting of 2 or 3, seldom 4 lobules, near the inner canthus in the nasal part of the upper eyelid, or a little higher up in the conjunctiva near the fornix (Figs. 17 to 20); another one, consisting usually of 2 lobules, I find in the nasal conjunctiva of the lower eyelid, below the lacrymal caruncle (Figs. 21, 22), and frequently one in the temporal side of the lower eyelid

somewhat nasally removed from the palpebral lacrymal gland.

When studying horizontal sections through the eyelids such little glands are sometimes found, also, to lie close to the temporal and nasal edges of the tarsus of the upper as well as the lower lid, and partly in the ocular conjunctiva. They are formed of one or two minute glandular lobules. All of these glands are of exactly the same histological structure as those generally recognized as lacrymal glands. Their excretory ducts, from their situation, are rather short. They, also, are lined with cylindrical epithelium. Their external orifice lies usually in the palpebral, sometimes in the ocular conjunctiva (Figs. 23 to 25).

There is no reason, as far as I can see, why these small isolated acinous glands should not also be looked upon as lacrymal glands, as they differ in no way histologically from them. The difference in size is the only one I can recognize.

The presence of these glands alone, then, could explain why, after the operative removal or the destruction of the orbital and the larger palpebral lacrymal glands in the temporal half of the eyelids, the surfaces of the eyeball and eyelids do not become dry. It is, furthermore, clear that when a chronic inflammation, involving the whole of the conjunctiva, gradually leads to its shrinkage and to the consequent obliteration of the excretory ducts and secondarily to atrophy of all these glands (and of some to be described presently), as for instance trachoma, xerophthalmus must result.

GLANDS SITUATED IN THE TARSAL TISSUE OF THE EYELIDS.

The tarsal tissue proper of the eyelids contains two forms of glands, namely, the so-called Meibomian glands and the acino-tubular (Waldeyer) glands.

The Meibomian glands are found in the upper lid to be about 30 in number, while in the lower lid they are only about 20. There are, however, individual variations as to these numbers. They are long, slender glandular structures, somewhat resembling the pancreatic glands, consisting each one of a central duct to which are attached numerous round, vesicle-like acini (Fig. 26). These central ducts

never quite reach the upper (in the lower eyelids the lower) edge of the tarsus. The acini begin somewhat removed from the external orifice of this central duct and sit upon it very much like grapes on the central stem. They form usually four rows around it, one on the posterior and one on its anterior surface, one on its nasal and one on its temporal side (Figs. 27, 28). The external orifices of the excretory ducts lie side by side at the free edge of the lid behind the lashes. The dermal epithelium reaches inwards into these ducts for some distance, as is particularly well shown in the eyelids of the Negro (Fig. 26).

The acini of these glands as well as their ducts are lined with several layers of flat polygonal epithelial cells. These continually undergo a fatty degeneration and thus form a sebaceous secretion which renders the lid margins fatty and thus helps to retain the tear-fluid within the conjunctival sac. In their structure these glands differ in no way from the sebaceous glands of the skin; they differ only in size.

The length of the individual Meibomian glands varies according to the height of the tarsal tissue. Thus, the longest ones lie in the middle line of the eyelid, and from there they grow gradually shorter towards both canthi. The most nasally or temporally situated ones often consist only of the central duct and two or three acini.

I can find only one layer of Meibomian glands, and all statements, referring to two or even more layers, are undoubtedly due to oblique sections. In a general way these glands run parallel to each other and at right angles to the lid margin. Yet, deviations from this rule are not uncommon (Fig. 28).

The second kind of glands, the acino-tubular ones (Wald-eyer), are usually drawn and described as lying solely in the temporal part of the tarsus above (in the lower lid below) the Meibomian glands (Fig. 29 to 31). This seems to be their most frequent location, or at least, they seem to be generally best developed in this portion of the tarsus. They are however, at least in the upper eyelid, quite frequently found to be located, also, near and in the middle line (Figs. 23 to 25),