EUROPEAN JOURNAL OF BIOMEDICAL AND PHARMACEUTICAL SCIENCES
http://www.ejbps.com

ISSN 2349-8870
Volume: 6
Issue: 3
301-307
Year: 2019

CONCEPT OF TEAR FILM (*ASHRU*) IN AYURVEDA

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Article Received on 23/12/2018 **Article Revised on 14/01/2019** **Article Accepted on 05/02/2019**

ABSTRACT
The exposed part of the ocular globe i.e. the cornea and the bulbar conjunctiva is covered by a thin fluid film known as preocular tear film. Tear film is that surface of the eye, which remains directly in contact with the environment. It is critically important for protecting the eye from external influences and normal functioning of ocular surface. In *Ayurveda* there is no direct explanation of *Ashru*. Hence, here it is found the need to understand the tear film on the ground of *Aurveda* in context of *Dosha* and *Dhatu*.

KEYWORDS: Ashru, Dosha, Dhatu, Tear film.

INTRODUCTION

Ashru means that remains spread over the *Netra.*[1] Its consistency is clear, non-viscous and watery, as evident from its synonyms[1] and its comparison with waterfall. This term appear in references of disease as well as physiological secretion.

Sharngadhara has used the term *Netrajala*, which point toward the clear watery nature of the fluid.[2] It is evident that *Ashru* plays an important role in the ocular surface cleansing mechanism by its excessive production in acute ocular surface inflammations i.e. *Aamayukta Netraroga.* [3] This cleansing function is also mentioned in Amarakosha (*Tamasru Netravaranam Pramrijiya*).[4] From the prodromal phase of *Netra rogas* itself the increased production of *Ashru* is described by *Aacharyas*.[5] Most of the diseases affecting the *Sarvaakshi* (Whole parts of eye) which causing acute inflammations are characterized by the extreme production of *Ashru* (tears) like *Abhishyanda*, *Sashopha* & *Ashopha Akshipaaka* etc.[6] As soon as the acute inflammation of the eye subsides, the production of *Ashru* will come to the normal level.

By considering the position, composition and function, it is evident that the tear film can be considered as part of *Baahya Patala*. The word *Patala* means a veil, enclosing membrane/layer or a film over the eyes.[7] The *Tejo-Jalaasrita Baahya Patala* usually compared with the structures like cornea, sclera including the conjunctiva and aqueous humor. Analysis of *Baahya Patala* as tear film includes the discussion on following points.

1. Position: It is the first Patala of *Akshigolaka*[8] (eyeball proper) which is situated outermost of four *Patalas* of eyeball and vitiation of this *Patala* can cause blurring of the vision (*Timira*).[9] Even though the *Drishti* is covered by the *Baahya Patala*, the *Rupagrahana Saamarthya* (ability to perceive objects) of *Drishti* is not interrupted due to the transparency of the *Baahya Patala*.[10] It indicates that this *Patala* is entirely transparent and situated in the outer part of eyeball covering the *Drishti mandala.*

2. Composition: *Prathama Patala* is also called as *Tejo Jalasrita Patala* due to its origin and nutrition from the *Rasa Dhatu* and *Siragata Rakta*[8]. *Rakta Dhatu* contributes to the *Jeevana* function of *Rasa* and it helps to maintain the normal luster of ocular surface by virtue of its *Varnaprasadana* property.[11]

3. Functions

Nutritive function: *Rasa Dhatu* is responsible for the functions like *Snehana* (Lubrication), *Tarpana* (Nutrition) and *Dhaarana* (Protection)[12] in the ocular surface. *Arunadatta* mentioned that *Indriyaprasadana* function is the contribution of *Rasa Dhatu*[13]. *Rasa* with the help of *Rakta Dhatu* will fulfill the function of *Jeevana* (vivifying).[12,13]

Optical function: *Prathama Patala* is extremely important for maintaining the perfect vision, which is evident from the feeling of blurring of vision when *Doshas* vitiate the *Baahya Patala*.[14] Due to the involvement of fluctuating *Dhatus* like *Rasa* and *Rakta*, this feeling of blurring is transient.[15] If proper treatment

is not taken, this may lead to the vitiation of successive *Patalas* and may cause severe diminution of vision and ultimately total blindness.[16]

Protective/Defensive function: While describing the function of *Rakta*, *Indu* mentioned that *Oja* is *Raktamaya* and due to this only *Rakta* can perform the function of *Jeevana*.[17] This opinion is again clarified by Dalhana while describing the *Balalakshana*. According to his opinion, *Rasa* and *Rakta* are considered as the *Oja* which can maintain the *Vyadhikshamatwa*.[18] *Arunadatta*, the commentator of *Ashtaanga Hridaya* defined the *Jeevana Karma* as "*Ojovriddhikaram*", which is the specific function of Rakta.[13] So this *Rasaraktaasraya Patala* will definitely contribute to the *Vyadhikshamatwa* i.e. ocular surface defense mechanism.

By the description of above points, it is obvious that tear film should be considered as the part of *Prathama Patala* with formation from *Rasa Rakta Dhatus* and serves the important functions like nutrition and protection of ocular surface and maintains the proper optical function of eye.

Constitution of *Ashru* (Tear film): In *Ayurveda* there is no direct quotation for detailed composition of *Ashru* is available, but during the description of functions of different *Dhatus*, *Acharyas* gave few stances regarding the dynamics of *Ashru*. After analyzing the clinical feature "*Netra Shushkata"* produced from different etiological factors, it is clear that *Acharyas* were well familiar with the two major components of the *Ashru* i.e. aqueous and non-aqueous parts. The *Rookshata* and *Shushkata* develops in *Vaataja Pandu*[19] is due to the involvement of aqueous part (*Rasa Kshaya*) where as the *Shushkata* develops in *Vaataabhishyanda* is due to the involvement of non-aqueous part (*Dooshika Kshaya*/*Dooshika Rahitatva*) because the watery secretion is normal in this condition.[20]

Rasa Dhatu contributes the major part in tears so that the term „*Netrajala*" is used to denote *Ashru*[21] i.e. aqueous part and perform the functions like *Tarpana* & *Preenana*.[22] The intimate relation between *Rasa Dhaatu* and *Ashru* is evident from clinical features like *Shosha* and *Alpa Cheshta* in *Rasakshaya*.[23] The production of *Ashru* from *Rasa Dhatu* is again substantiated by the manifestation of dryness of eyes in *Vaatika Jw*ara[24], *Vaataja Pandu*[25], where the mainly involved *Dhatu* is *Rasa*. *Acharya Charaka* opined that if a person is subjected to excessive *Langhana* therapy, then the features like *Mukha Shosha* (dryness of mouth) and *Netra Daurbalya* (ocular fatigue) will develop.[26] This statement also draws attention to the role of *Rasa* in keeping the eye healthy.

Mamsa Dhatu serves the function in ocular surface by its role in the *Deha Lepa* & *Medapushti*.[27] The *Mala* (excrement) of *Netra* is the contribution of *Mamsa* and the feature of *Aksha glani* in *Mamsakshaya* also substantiates its function in maintaining the ocular surface integrity.[28]

Medo Dhatu contributes to the *Netra Snigdhata*[29] and the *Kshaya* of this *Dhatu* also causes the *Glani* (fatigue) of *Netra.*[30]

Majja Dhatu also plays a part in the *Netra Snigdhata* by the contribution of *Akshi Sneha* as its *Mala*[31]. This is also apparent from the manifestation of *Netra Gourava* in *Majja Vriddhi*[32] and *Timira Darshana* (blurring of vision) in *Majja Kshaya.*[31]

While describing the properties of the *Malas* (excretions), *Acharyas* clearly mentioned that their presence in proper amount is essential for the maintenance of integrity of their respective sites and whole body. The deficiency results in dryness, pain and numbness in the respective sites.[33]

So, it is evident from the above facts that non aqueous part is contributed by the *Mamsa*, *Medo and Majja Dhatu*.

Role of *Rakta Dhatu*: *Kshaya* and *Vriddhi* of *Dhatu* are maintained by the *Rakta*[34] (*Tesham Kshaya Vriddhi Shonita Nimitthai),* so to stabilize the *Rasa*, *Mamsa*, *Meda* and *Majja Dhatu* for the proper formation of tear film, appropriate functioning *Rakta Dhatu* is essential. It is also evident that *Rakta* possess the properties of *Pitta* and *Kapha* by describing its basic nature as „*Madhuram Lavanam Kinchith Asheetoshnam Asamhatam*.[35] Thus it helps to maintain the equilibrium of *Dhatu*[36] ('*Dehasya Rudhiram Mulam Rudhirenaiva Dharyatae')* by its *Soumya* and *Agneya* properties. It is also apparent that *Rasa* and *Rakta Dhatu* complement each other and it is difficult to separate these two entities.[37]

Rakta Dhatu contributes the normal luster of eye (*Varna prasadana*) and *Acharya Charaka* mentioned that *Suddha Rakta Dhatu* is essential for the smooth functioning of all *Indriys* and for maintaining the *Bala*[38] (local and general immunity). The manifestation of *Timira Pradurbhava* in *Rakta Kshaya*[39] also complements this concept.

From the above thoughts, it can be concluded that *Rasa Dhatu* contribute the major aqueous part of tears and latter non-aqueous part is contributed by the *Mamsa, Medo and Majja Dhatu. Rakta Dhatu* assimilates the contributions from different *Dhatu* and *Dhatumala* and helps to form and maintain a stable tear film.

Concept of Tear film in modern ophthalmology

The primary role of the tear film is to establish a refractive surface of high quality for cornea and to ensure the well being of corneal and conjunctival epithelium. The tear film is formed and maintained by an elaborate system – the lacrimal apparatus consisting of secretary, distributive and excretory parts. The secretary part

includes the lacrimal gland, accessory lacrimal gland tissue, sebaceous glands of the eye lids, goblet cells and other mucin-secreting elements of the conjunctiva. The elimination of the lacrimal secretions is based on the movement of tears across the eye aided by the act of blinking and a drainage system consisting of lacrimal puncta, canaliculi, sac and nasolacrimal duct.[40]

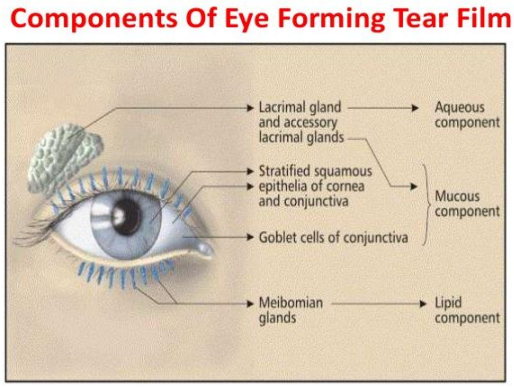


Figure. 1: Components of eye forming tear film.

About 95 percent of it is produced by the lacrimal gland and lesser amount is produced by goblet cell and the accessory lacrimal glands of the conjunctiva. The total mass of the latter is about one-tenth of the mass of the main lacrimal gland. The secretary part of the lacrimal apparatus provides the aqueous tear, lipids and mucus; all the important components of the tear film and its boundary. The tear film composed of following three layers.[41]

1. Superficial Lipid Layer

The superficial layer at the air-tear interface is formed over the aqueous part of the tear film from the oily secretions of meibomian glands and the accessory sebaceous glands of Zeis and Moll. The meibomian gland openings are distributed along the eyelid margin immediately behind the lash follicles.

The chemical nature of the lipid layer is essentially waxy and consists of cholesterol esters and some polar lipids. The thickness of this layer varies with the width of the palpebral fissure and is between 0.1 and 0.2 µm. Being oily in nature it forms a barrier along the lid margins that retains the lid margin tear strip and prevents its overflow on to skin. This layer is so thin that there are no interference colour patterns such as one normally sees on an oily surface. However, if one squints, the oily layer thickness and distinct interference colours may be seen.

While the bulk of tarsal gland secretions are non polar lipid compounds which do not spread over an aqueous surface alone, many surface active components are also present. It appears that the tarsal gland secretions which are transported to the cornea in the tear film are massaged into the outermost layer of corneal epithelium cells by eyelid action and then possibly are changed by local metabolic processes in the epithelium combining with conjunctival mucus to form a stable hydrophilic base for the pre corneal tear film.

This outer lipid layer has the following main functions

1. It reduces the rate of evaporations of the underlying aqueous tear layer.
2. It increases surface tension and assists in the vertical stability of the tear film so that tears do not overflow the lower lid margin.
3. It lubricates the eyelids as they pass over the surface of the globe.

2. Middle Aqueous Layer

The intermediate layer of tear film is the aqueous phase which is secreted by the main lacrimal gland and the accessory glands of Krause and Wolfring.

This layer constitutes almost the total thickness of the tear film 6.5 to 10 µm, many times thicker than the fine superficial oily layer. This layer contains two phases – a more concentrated and a highly dilute one. The interfacial tension at the adsorbed mucin – aqueous layer is apt to be rather small due to the intensive hydrogen bond formation across the interface. This layer contains inorganic salts, water proteins, enzymes, glucose, urea, metabolites, electrolytes, glycoproteins and surface active biopolymers. Uptake of oxygen through the tear film is essential to normal corneal metabolism. This layer has four main functions.

1. Most importantly it supplies atmospheric oxygen to the corneal epithelium.
2. It has antibacterial substances like lactoferrin and lysozyme. Therefore, dry eye patients are more susceptible to infection than a normal eye.
3. It provides smooth optical surface by removing any minute irregularities of the cornea.
4. It washes away debris from the cornea and conjunctiva.

3. Posterior Mucin Layer

The innermost layer of tear film is a thin mucoid layer elaborated by goblet cells of the conjunctiva and also by the crypts of Henle and glands of Manz. It is the deepest stratum of the pre corneal tear film. This layer is even thinner than the lipid layer and is 0.02 to 0.04 µm thick. This adsorbs on the epithelial surface of the cornea and conjunctiva rendering them hydrophilic. It assumes the ridged appearance of the microvilli of superficial epithelial cells which it covers. The pre ocular tear film is dependent upon a constant supply of mucus which must be in proper chemical and physical nature to maintain corneal and conjunctival surfaces in the proper state of hydration. The mucous threads present in the tear film provides lubrication allowing the eyelid margin and palpebral conjunctiva to slide smoothly over one another with minimal energy lost as friction during blinking and ocular rotation movements. They also cover foreign bodies with a slippery coating thereby protecting the cornea and conjunctiva against the abrasive effects of

such particle as they are moved about the constant blinking movements of the eyelids. The mucus contributes stability to the pre ocular tear film as well as furnishing an attachment for the tear film to the conjunctiva but not to the corneal surface. The corneal surface is covered with a myriad of fine microvilli which provides some support for the tear film. The mucus dissolved in the aqueous phase facilitates spreading of the tear film by smoothening the film over the corneal surface to form a perfect, regular refracting surface.

So, the mucin layer which is glycoprotein in nature converts a hydrophobic surface into a hydrophilic surface and enables the corneal epithelium to be adequately wetted.

In addition to sufficient amounts of aqueous tears and mucin, three other important factors are necessary for effective resurfacing of the cornea by the pre corneal tear film.

A normal blink reflex is essential to ensure that the mucin is brought from the inferior conjunctiva and rubbed into the corneal epithelium. Patients suffering from facial palsy and lagophthalmos therefore develop corneal drying.

Congruity between external ocular surface and the eyelids ensures that the pre corneal tear film shall spread evenly over the entire cornea. Patients suffering from limbal lesions like dermoids face the problem of apposition of the eyelids to the globe leading to local selective areas of drying. Normal epithelium is necessary for the adsorption of mucin on to its surface cells. Patients suffering from corneal scars and keratinizations have problem of interference with the corneal wetting.

In *Ayurveda* there is no evidence of origin of *Ashru* but we can assume that *Ashru* is originated from *Kapha* so posseses *Kapha* like properties, and provides lubrication and immunity by its *Bala* activity. *Acharya Bhavamishra* has described that *Akshivita* (*Mala* of *Majja*)is brought in the eye by *Vyana Vayu* through *Sira* and deposited there.[42] There are two *Ashruvahini Dhamani* (one in each eye).[43] These channels are concerned with carriage of *Ashru*, although it is not clear whether these channels are related with secretion or excretion of *Ashru*.[44]

Another structure associated with transmigration of *Ashru* is the *Ashrumarga*[45] referred in the description of '*Srava Roga'*. *Ashrumarga* are derived from *Akasha Mahabhoot* which is having space[46] similarly as Lacrimal passages. *Ashrumargas* are situated in *Kaneenaka Sandhi*.[45] As regards their working, it is clear from their anatomic location and description of function that these are concerned with the drainage of *Ashru*.

As its clear from above that *Rasa*, *Meda* and *Majja Dhatu* are responsible for formation of *Ashru*. The tear film coating the eye also has three distinct layers, from the most outer surface which may be correlated as-
1. Lipid layer- lipoid Secretions of *Meda Dhatu*
2. Aqueous layer- water secretions of *Rasa Dhatu*
3. Mucous layer- secretions as *Majja Dhatu Mala* in form of *Akshivita.*

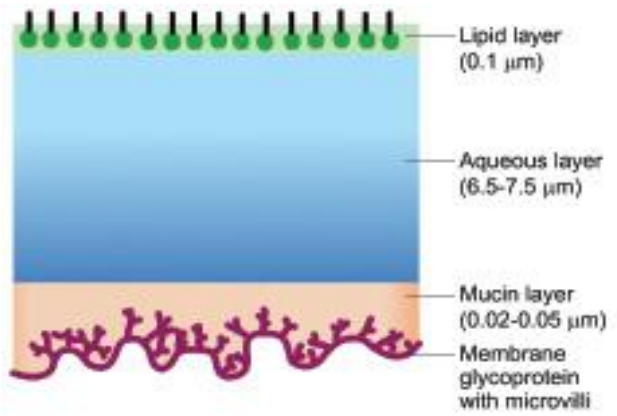


Figure. 2: Structure of tear film.

Secretion of tears: Tears are continuously secreted throughout the day by accessory (basal secretion) and main (reflex secretion) lacrimal glands. This concept of „basal tear secretion" is presently thought to be redundant one; as even minimal tear production in the undisturbed eye is thought to be secondary to light or temperature stimulation or both (proprioreceptors in the lids may also play a part). Reflex secretion occurs in response to sensations from the cornea and conjunctiva, probably produced by evaporation and break up of tear film. Hyper lacrimation occurs due to irritative sensations from the cornea and conjunctiva. Afferent pathway of this secretion is formed by fifth nerve and efferent by parasympathetic (secretomotor) supply of lacrimal gland.

According to *Ayurveda*, the basal secretion of *Ashru* is controlled by *Vyana Vayu* as reflected by the *Karma* of *Vyana Vayu* i.e *Visravana Karma*.[47] *Prana Vayu* stays in *Murdha*[48] so the sensation for reflex secretion of *Ashru* comes from the fifth cranial nerve and parasympathetic fibres due to action of *Prana Vayu.*

Dynamic events during blinking[49]

A complex series of events take place during the process of blinking. As the upper lid moves downwards, the superficial layer is compressed. As it thickens it begins to exhibit interference colours. The whole lipid layer together with the associated biopolymers is compressed between the lid edges. Lipid epiphora almost never occurs as the compressed lipid layer between closed eye lids has a thickness only of 0.1μm.

When the eye opens, at first the lipids spreads in the form of a monolayer against the upper eye lid. In this spreading process, the limiting factor is the motion of eyelid. The spreading of the excess lipid follows and in about 1 sec. multimolecular layer of lipid is formed. The

spreading lipid drags some aqueous tears with it, thereby thickening the tear film. The magnitude of this effect is controlled by the size and shape of tear meniscus adjacent to lid edges. As soon as there are insufficient tears to form a saturated meniscus, a local thinning adjacent to the meniscus, takes place which effectively prevents further fluid flow from the meniscus to the tear film.

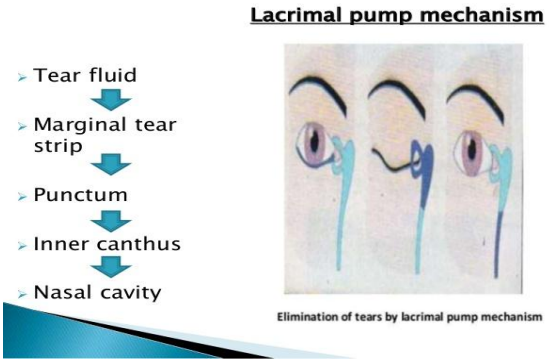


Figure. 3: Lacrimal pump mechanism.

Drainage of lacrimal fluid from lacus lacrimalis into the nasolacrimal duct: The lacrimal fluid flows over the pre ocular surface and reaches the marginal tear strip running along the ciliary margin of each eye lid and collects as lacus lacrimalis in the inner canthus. From the lacus lacrimalis and along the marginal tear strip, the lacrimal fluid is drained by the lacrimal passages into the nasal cavity. This is brought about by an active lacrimal pump mechanism constituted by fibres of the preseptal portion of the orbicularis which arise from the lacrimal facia and posterior lacrimal crest (Horner‟s muscle). This lacrimal pump operates with the blinking movements of the eyelids as follows.

A. On eyelid closing movement, following three events occur concomitantly

1. Contraction of pretarsal fibres of the orbicularis compresses the ampulla and shortens the canaliculi. This movement propels the tear fluid present in the ampulla and horizontal part of the canaliculi toward the lacrimal sac.

2. Contraction of preseptal fibres of orbicularis pulls the lacrimal facia and lateral wall of the lacrimal sac laterally, thereby opening the normally closed lacrimal sac. This produces a relative negative pressure and draws the tears from the canaliculi into the lacrimal sac.

3. Along with the increased tension on the lacrimal facia (which opens the lacrimal sac), the inferior portion closes more tightly, thereby preventing aspiration of air from the nose.

B. When the eyelids open, tone in the orbicularis muscle is decreased and following events occur concomitantly

1. Relaxation of pretarsal fibres of the orbicularis allows the canaliculi to expand and reopen. The expansion of the canaliculi and ampullae draws in the lacrimal fluid through the puncti from the lacrimal lake.

2. Relaxation of the portion of the preseptal fibres (Horner‟s muscle) allows the lacrimal sac to collapse.

The collapse of the lacrimal sac expels the fluid therein downwards into the now open nasolacrimal duct.
Therefore, in atony of the sac tears are not drained through the lacrimal passages, in spite of anatomical patency, resulting in epiphora.

Drainage of lacrimal fluid from nasolacrimal duct (NLD) into the nasal cavity: Once the lacrimal fluid enters the upper end of the NLD, the influence of eyelid movements on its further downward flow ends. Factors which influence the flow of tears along the NLD are as follows.

1. *Gravity* helps in downward flow.

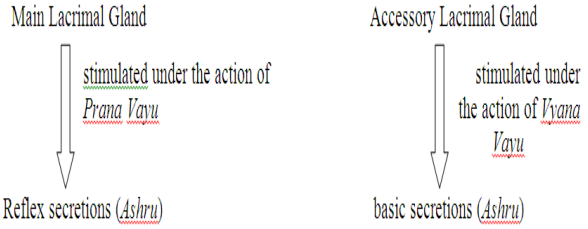
2. *Air current movement within the nose:* The opening of NLD in the nasal cavity is so placed that air current passing either inward or outward, induce a negative pressure within the NLD and thus draw the fluid down the potential lumen of the duct into the nose.

3. *Hasner's valve* present at the lower end of NLD remains open as long as the pressure within the nose is less than the NLD and thus allows the tears to flow from the NLD into the nose. However, when the intranasal pressure increases (as on blowing the nose) the Hasner‟s valve closes, thereby preventing the reflux upward.

From the nose, the tears pass posteriorly with the nasal mucus secretions.

Tear film is spread by blinking of eye lids. *Vyan Vayu* is responsible for opening and closing the eyes[50], so responsible for spreading the *Ashru*. Excretion of tears through nose is under the control of *Apana Vayu*[51] through its *Dharana* of *Mala*(*Akshhivitta*) and *Utsarga Karma.*

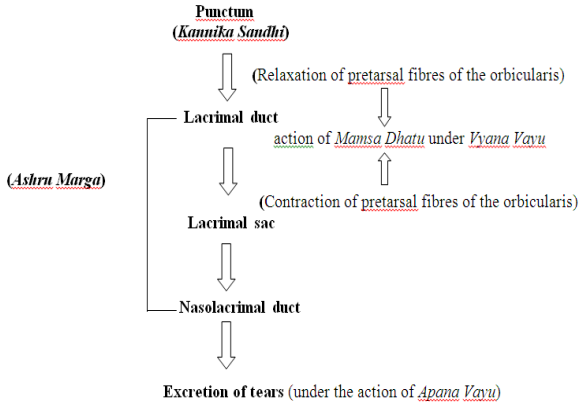
Secretion



Distribution

By the action of lids which is under the control of *Vyana Vayu*

Excretion



CONCLUSION

Ashru is very important for proper functioning of eyes. Comparison of modern aspect of tear film in relation to Ayurveda is valuable in context of treatment. Epiphora resulting from vitiation of *Vyana Vayu* leads to excessive production of *Ashru*, hence line of treatment should be correction of *Vikriti* of *Vayu*. Likewise other abnormalities of tear film should be understand on the ground of *Ayurveda*, for this *Ayurvedic* aspect of tear film is mandatory.

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