Role of Lacrimal Gland in Tear Production in Different Animal Species: A Review

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Abstract

The lacrimal gland is a serous acini lobulated gland which have comprised of cuboidal epithelium. The secretary variations are observed in different domestic animals. In swine, the secretion is mucous in nature. The cells are showing mucin reaction in sheep, goat and dog. Lacrimation is one of the physiological events that protects the eye ball and further prevents the pathogenic infection. There are small accessory glands which found in the third eyelids and it further contributes approximately 50% composition of the tear film. The pre-corneal surface protected by mucus coating which is secreted by the goblet cells of conjunctival membrane.

Key words: Lacrimal, Mucin, Tear film, Precorneal, Conjunctival, Acini.

1. Introduction

The eye is a complex and highly developed organ which collects light from the surrounding environment. It regulates its intensity through a diaphragm, focuses it through an adjustable lens to form an image on retina where this image is converted into a set of electrical signals and transmitted to the brain. The eyes are protected in the skull by a bony box called the eye socket (orbit). The wall of this eyeball consists of three layers which have different tasks in the anterior and posterior halves of the organ (Konig and Liebich, 2007). One of the accessory structures of the eye is the lacrimal apparatus which located superiorly and laterally to each eyeball. Each lacrimal apparatus consists of the lacrimal gland, canalicule, lacrimal sac and naso lacrimal duct. The lacrimal gland is responsible for production and secretion of tears which clean and nourish the cornea and help to maintain corneal health. The lacrimal apparatus are responsible for the production, dispersal and disposal of the tears.

The lacrimal fluid keeps the anterior surface of the eyes moist and clean. In addition to salts (NaCl-1%), it contains small amount of protein. The lacrimal secretion also consists of bactericidal enzyme known as lysozyme which may be considered part of the defense against infection. The pre-corneal tear film protects the eyes by washing away foreign material. It is essential in maintain the transparency of the cornea. Insufficient tear production results in opacification. The keratoconjunctivitis sicca (KCS) is a chronic inflammatory disease due to quantitative or qualitative abnormalities of the tear film, frequently reported in dogs. The lacrimal gland can be involved in immune-mediated, toxic, infectious, or cancerous processes (Slatter, 1973; Hirayama et al., 2000 and Vinayak et al., 2004). The normal volume of tear fluid is about 5–10µl per day.

2. Lacrimation

Animals do not tear up or cry for emotional reasons as humans do. Secretion of tears serves to clean and lubricate the eye in response to an irritation of the eyes. Tearing can be an indicator of irritation, inflammation, injury or infection to the eye. Possible causes of lacrimation in pets are limited to allergy, physical or chemical irritant, misplaced eyelashes, eyelid growth, and chemical spill, wound or direct injury, corneal ulcer, blocked tear ducts, some systemic diseases or toxin ingestion.

Tear or lacrimation is considered to have a unique structure with functions of nourishing, lubricating and protecting the ocular surface, containing lipid, protein, and mucous components (Tiffany, 2008; Ohashi et al., 2006). Proteins in the tear are play an important role in protecting the ocular surface from the pathogens, maintaining the integrity and stability of the tear and modulating the ocular wound healing process (Zhou et al., 2007). The comprehensive and comparative analysis of tear proteins can be helpful in the studies of pathophysiological mechanisms and diagnosis of ocular surface diseases. The healthy ocular surface is associated with normal tear production and the stability of the tear film, which are found to be affected by several endogenous and exogenous factors, such as...
age, gender, the time of day, and environmental conditions (Piccione et al., 2008).

Studies on humans and animals have reported the daily variations of tear production. The potential influence of season has also been evaluated in tear production of normal horses by Schirmer tear test. However, no statistically different Schirmer tear test values were found in winter compared to the respective values in summer (Beech et al., 2003).

3. Composition of Tear Film

The lacrimal gland (LG) is an epithelial gland that is responsible for approximately 60% of the production of the aqueous component of the pre-corneal tear film with the remaining 40% contributed by the accessory lacrimal gland of the third eyelid (Junquira and Carneiro, 2003). The major secretory sources of protein are to optimize the optics of the cornea, to lubricate and to protect the eye from the pathogens. Tear film is made up of tri-laminar structure 7μ thickness which consists of lipid, aqueous and mucin (Mohamadpour, 2008). The lacrimal film is composed by three layers, differing in composition:

- An outer superficial layer consisting of lipids, produced by the meibomian glands;
- An intermediate one, composed of aqueous components, produced by the lacrimal and third eyelids superficial glands; and
- An inner layer, consisting of mucin produced by goblet cells.

The outer superficial oily layer provides lubrication and prevents overflows of tear from the eye lid margin. It retards evaporation of the underlying aqueous layer. This lipid layer acts as a lubricant allowing for the smooth movement of the eyelids over the globe. The lipid components also lower the surface tension of the tear film, which may promotes the integrity of the aqueous portion. The aqueous layer is the major component of tear film. It is formed by electrolytes, water, and proteins. These components are principally secreted by the lacrimal gland composed of acini lobules. The lumen of each acinus is lined by columnar epithelial cells. These cells are surrounded by a basal layer of myo-epithelial cells enclosed by a basement membrane. The fluid produced by the lacrimal gland through intra-lobular and interlobular ducts drain into the conjunctival space beneath the upper eyelid. As a result of eyelid movements, the tears fluid flows over the cornea and produce a thin layer of the fluid on the cornea. It nourishes and moistens the cornea further. During the periods between blinks, a slow and continuous evaporation takes place from the corneal surface but the thin layer of lipid produced by tarsal (Meibomian) gland to some extent prevents evaporation of the aqueous layer. The innermost layer is produced by the goblet cells of the conjunctival epithelium and assists in adherence of the pre-corneal film to the corneal surface (Dartt, 2004). Prabha (2014) reported that the tears are useful because they have important proteins, immunoglobulins including its role in defense of the eye. Tears also have antimicrobial activity due to lactoferrin present in it. Tears wash away the unwanted substances present in the eye. Crying helps in expressing our emotions and also to overcome sorrow. Tear film helps to maintain visual acuity and contains major proteins.

4. Different Species

There are adequate researches documenting the anatomy and histology of lacrimal glands in human and some other mammals. In all investigated species, the lacrimal gland has presented more or less a similar histological structure and is a mixed gland consisting of tubulo-acinar units (Gargiulo et al., 1999). In most species, the maximum amount of tears is secreted from the dorsal lacrimal gland (Carrington et al., 1987; Nguyen et al., 2006). The examination of lacrimal glands of human beings, dogs, cats, horses, pigs, rabbits, sheep, goat and guinea pigs has been described (Sinha and Calhoun, 1966; Allen et al., 1972; Krochmalska, 1976; Gillette et al., 1980; Martin et al., 1988 and Gargiulo et al., 2000). In many species, the main fraction of tears is produced by lacrimal glands. In cattle and wild buffalo, no difference is observed between left and right glands. Moreover, in these animals no sexual dimorphism is evident in the case of the lacrimal gland (Pinard et al., 2003).

The lacrimal puncta were absent in the anatomy of the dromedary lacrimal apparatus. The absence lacrimal puncta in some mammals does not entirely deprive the nasal mucosa of the moistening effect of the lacrimal fluid. But in the camel that moistening effect is excluded by the absence of the puncta. The absence of the puncta causes excess lacrimal fluid to escape by flowing over the lower eyelid. This probably explains the popular myth that the camel is so emotional that it sometimes popularly referred as “sheds tears” (Abdalla et al., 1970 ; Saber and Makady, 1987). 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.

Probably, the Lacrimation stimulated by the mechanism of the gustatory-lacrimal reflex between the gustatory nuclei and the salivary nuclei (including the lacrimal nuclei) in the brain stem. Lacrimation can also be a part of the complicated synkineses of yawning, coughing, and vomiting.
5. Conclusion

The lacrimal glands and its secretary function in various species is an insight to applied research models to overcome the different clinical affections of eyeball at large. In camel, the flow of the lacrimal secretion does not carried by naso-lacrimal duct as in horse. The gender related differences exists in lacrimal gland of rats, guinea pig, rabbits and human beings. Some breeds of dog are more prone to develop keratoconjunctivitis sicca with being females are more affected than males. The lacrimation is physiological event that to protect the normal pre-corneal surface as well as it possess bactericidal properties. The modern therapy as in art of living that encourages the crying positively and it brings an emotional burst out and mental well being as in human life.

References


