

## DRY EYES

The surface of the normal eye is covered by a thin layer of tears. The normal tear film is the front optical surface of the eye, assuring a mirror-like surface for focusing light. As the first line of defense against infections, a stable tear film also maintains the health of both the surface of the eye itself and the internal surface of the lids. It is generally believed that the ocular tear film is made up of two components:

- an innermost (that is, against the surface of the eye) mucous layer derived from cells in the conjunctiva, a middle watery layer produced mainly by the tear glands and
- an outer surface of a thin layer of oil, primarily derived from glands in the lid margin adjacent to the eyelashes.

This tear film is spread mechanically over the surface of the eye by the normal blinking of the eyelids, much like windshield wipers spread materials across the surface of a windshield. Through blinking, the old used tears are removed from the surface of the eye and drained through small ducts (called the puncta) in the corner of the lids down into the nose.

Many different disorders of the eye affect the stability of the tear film; an unstable tear film is a hallmark of “dry eyes”. Proper classification of the cause of a tear deficiency is critical for several reasons:

- 1 appropriate therapy depends on proper diagnosis
- 2 certain conditions of dry eyes are associated with sight-threatening complications in the cornea (the transparent “watch crystal” of the front surface of the eye) and
- 3 some conditions are associated with systemic immune abnormalities that may affect other organ systems.

In adolescents and adults, dryness may give rise to several subjective sensations of irritation: burning, stinging, itching, foreign body irritation, dryness, soreness, heaviness of the eyelids, sensitivity to light, and “fatigue”. These complaints are so diverse, because the surface of the eye lacks any specific sensors for “dryness”, therefore people use a wide range of sensations to describe their symptoms. Similarly, certain activities that prolong visual efforts, such as reading or watching television or a film, can worsen the symptoms by decreasing the rate of blinking and therefore promote drying of the surface by evaporation, since the eyelids do not spread the tears normally. Prolonged exposure to air conditioning (where the humidity is low), smoky environments (where pollutants and irritants are present in the air) and the low humidity of airline cabins (that may be less than 10%, similar to the Sahara Desert), may also provide useful clues to the cause of a person’s symptoms. A long list of medications also are associated with decreased production of tears by the tear glands, including a number of blood pressure lowering agents, some antidepressants, a few antiarrhythmia drugs for the heart, some Parkinson’s disease drugs and a number of antihistamines.

Additionally, a number of medical disorders considered to be autoimmune in origin are regularly associated with dry eyes, or can aggravate already abnormally low tear production. These include rheumatoid arthritis, systemic lupus erythematosus, scleroderma, Hashimoto's thyroiditis, Raynaud's phenomenon, interstitial nephritis, and chronic hepatobiliary cirrhosis, among others.

In general, dry eyes can be categorized into two major groups, those in which there is inadequate production of the watery component of tears, and those in which the volume of water seems to be normal. However, since water alone is not the only component of tears, other aberrations in both the oil component and the mucous component can be defective and lead to the same symptoms of inadequate lubrication and moistening.

### **Deficient watery tear production**

Inadequate production of the water component of tears is produced by an under secreting tear gland, reducing the amount of tear production and tear flow. Sometimes called keratoconjunctivitis sicca (KCS), there is drying of both the surface of the cornea and the surface of the white part of the eye and inner surface of the lids from inadequate moisture.

Congenital alacrima (lack of tears) is an uncommon condition in infants and children resulting from the absence or underdevelopment of the lacrimal gland embryologically, or abnormalities in the nerve structures to the lacrimal glands that normally stimulate tearing. The most common genetic condition associated with alacrima is the Riley-Day Syndrome, in which decreased production of tears is associated with abnormal nerve structures in the lacrimal gland. Sometimes, such as in EEC Syndrome (Ectrodactyly-Ectodermal Dysplasia Clefing), the tear gland is not even constructed embryologically, and therefore the dryness of the surface of the eye can be severe.

In addition, especially in adolescents and adults, abnormal medical conditions can invade or replace tissues in the lacrimal gland and thus result in dry eyes, including lymphoma, sarcoidosis, and amyloidosis. In recent years, we have seen patients with AIDS develop dry eyes, apparently as a complication of the altered immune status. Even individuals with Hepatitis C infection can develop autoimmune disease causing tear gland insufficiency.

Rarely, abnormal nutrition can lead to dry eyes, and severe systemic vitamin A deficiency (sometimes after a small colon and stomach surgery, sometimes under protracted extremes of inadequate diet) can cause severe dry eyes.

Also, certain neurological conditions that affect signals from the brain to the tear gland itself, both alkaline and acid burns that scar the surface of the eye and destroy some of the surface cells, and a few endocrine imbalances (such as hyperthyroidism) can all lead to severe surface abnormalities and underproduction of the watery and other components of tears.

The most common general medical condition associated with tear deficiency is Sjögren's syndrome, also called "sicca syndrome". Sjögren's syndrome is a medical condition characterized by the combination of decreased tear production and dry mouth. Often the dry mouth and the dry eyes are associated with a systemic autoimmune disease, usually rheumatoid arthritis. Sjögren's syndrome has a consistent bias for women more frequently than men, especially women who are post-menopausal, over the age of 45.

### **Dry Eye with Adequate Watery Tear Production**

The other major category of dry eye includes those conditions with adequate watery tears, but abnormal tear dynamics as a result of increased tear evaporation. One cause is an abnormal function of the oil glands in the eyelids that produce the protective oily layer on the outside of the tear film. The normal function of this oil layer is, just as oil on water, to prevent the watery component of tears from evaporating. If there is scarring of the oil glands in the eyelids, a medical skin condition called Acne Rosacea, or some medications, such as retinoid therapy (Accutane and similar drugs), the volume of oil is reduced and therefore the tear film is unstable and evaporates more rapidly, leading to the same symptoms as water deficiency.

Other conditions that increase tear film evaporation may cause symptoms of dry eyes, even when the watery components of tears is normal, such as an increased width of the eyelids, (for example, in thyroid disease) or inadequate lid closure (in which case the “windshield wiper” effect of the eye lids blinking incompletely does not coat the surface of the eye with tears properly).

### **Therapy of Dry Eye**

Currently, the treatment of the irritation associated with dry eyes is largely directed at providing relief of the symptoms. Strategies are aimed at lubricating the surface of the eye and conserving tears that have produced. The mainstay of treatment for decreased aqueous tear production is topically applied lubricants and ointments. Although these agents often provide temporary relief of the symptoms, they obviously do not reverse the abnormalities of the ocular surface when the cells may be lost or scarred, especially over many years. Despite the availability of huge numbers of commercially available artificial teardrops, at the present time none is a true therapeutic tear replacement with normal biological activity. As a result, some individuals with severe tear deficiency and severe ocular irritation must put their artificial teardrops in several times an hour to keep their symptoms tolerable.

Unfortunately, this frequent installation of artificial tears with preservatives makes some individuals with aqueous tear deficiency susceptible to toxicity from the preservatives, particularly benzalkonium chloride. The arrival of preservative-free artificial tears in the last decade has allowed some individuals to use these preparations as frequently as they desire without experiencing surface toxicity or allergies from the preservatives. Preservative-free artificial tears should be considered by anyone who feels that they must instil these medications more than four or five times a day to relieve and control their symptoms. Dozens of such preparations are available “over-the-counter”, without prescription, in any chemist. Symptomatic individuals are encouraged to buy small bottles of several different brands to find one that is most soothing and that relieves the symptoms.

Lubricant ointments, which are basically sterile “grease” or “oil” in a solid form, are particularly useful before going to bed, because they have a longer contact time than drops and they will coat the surface of the eye during sleep, when the normal tear production is reduced. People with very severe dry eyes may also use lubricant ointments during the daytime, but most of them are bothered by the blurred vision, the sticky sensation, and “smear” experienced after use of the ointment that may last 15 to 30 minutes after each application.

Individuals who continue their symptoms in spite of maximal artificial tear supplements may benefit from other interventions aimed at saving their reduced volume of their inherently produced tears. A humidified environment is recommended to reduce tear evaporation. Room humidification is particularly beneficial in dry climates and at high altitudes. Tear evaporation can also be reduced by placement of side panels and moisture chambers around the frames of glasses. Covering the eye at

night or even taping the lids closed may also reduce tear evaporation. Some individuals may actually benefit from wearing swim goggles or by taping a plastic shield or plastic wrap over the eyelids at bedtime.

One of the most useful and practical therapies for conserving tears is punctal occlusion. The punctum is the medical name for the small “drain” near the corner of the eyelids, through which tears drain into channels down into the nose. Temporary occlusion of the punctum with small collagen plugs, and more recently with permanent plastic or silicone plugs that can be removed, are major advances. Indeed, some patients have silicone plugs in place for seven to ten years without any complication.

Permanent punctal occlusion performed either with a cautery or with a laser, can completely obliterate the lacrimal puncta. Unfortunately, if there is ever a need for re-opening the punctum, it cannot be done in any fashion, other than by an extensive surgical reconstruction, once it has been obliterated by these destructive methods. Therefore my bias has always been to use the silicone plugs, which can be removed easily if they are no longer needed.

Several years ago, a group of investigators suggested that a topical ointment called tretinoin (all trans-retinoic acid ointment), a form of vitamin A, might benefit individuals with keratitis sicca or Sjögren’s syndrome. A multicenter, placebo-controlled, double-masked study of the efficacy of tretinoin for keratitis sicca was performed and failed to find any benefit whatsoever. Additional clinical trials may be necessary to assess further benefits in vitamin A ointment.

In 1984, some investigators suggested that, compared to placebo, artificial tears made with autologous sera (the patient’s own blood clotted and the serum withdrawn and diluted one to three with normal saline) resulted in a substantial improvement in the symptoms of ocular irritation and decrease in ocular surface disease. However, no additional studies have evaluated artificial tears containing autologous sera, and their use is considered investigational only.

Dry eyes are a common feature of some of the Ectodermal Dysplasias, because of abnormal tear glands, lid disease, or defective production of the mucus, the water, or the oil layer of tears. Treatment of dry eyes in these situations is exactly the same as dry eyes in any of the described situations.

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