

Lubricant eye drops

The electrolyte factor

Dry eye is one of the most common conditions encountered by eyecare professionals. The literature suggests that about 14% of adults over 40 experience ocular dryness and discomfort. The prevalence among contact lens wearers is even higher, given that typical wearers are older, use multipurpose solutions or wear continuous wear lenses¹⁻³.

One of the mainstays of addressing these common issues is the use of topical lubricants. The marketplace, however, is crowded with lubricant eye drops or comfort drops. So, the question arises: apart from viscosity and the presence or absence of a preservative, are all drops similar? And if not, what are the differences?

This article discusses one difference that appears to have significant bearing on providing discernable relief – the amount and ratio of electrolytes in lubricant eye drops.

Maintaining the balance

The ocular surface epithelium is unique in that it does not have a blood supply. It derives its electrolytes and oxygen from the tear film. The tear film, in other words, is a vital fluid and, as such, the electrolyte balance of that fluid is crucial for biological function. If serum electrolytes are out of balance, for example, the consequences can be deadly, so the electrolyte balance in Lactated Ringers (used as a serum substitute) must match that of real serum. Similarly, the electrolytes in the balanced salt solution used intraocularly during eye surgery must match those of the aqueous humour. The same reasoning applies to the tear film, in that the electrolytes in eye drops need to match those of the tear film.

In our research, we found that unless an eye drop had an electrolyte balance that precisely matched that of the human tear film, there was a loss of conjunctival goblet cells (conjunctival goblet-cell density is a very sensitive indicator of ocular surface health, and goblet cells provide the natural lubrication for the ocular surface)⁴.

Electrolyte	Concentration (mMol/Litre)
Sodium (Na)	132
Potassium (K)	24
Bicarbonate (HCO ₃)	32.8
Calcium (Ca)	0.8
Magnesium (Mg)	0.61

» Table 1
Normal electrolyte concentration in human tears⁸

Published studies have shown that electrolytes such as potassium are critical to the maintenance of normal conjunctival goblet-cell density. Other important electrolytes in the tear film include sodium, calcium, magnesium and bicarbonate (four concentrations, see Table 1).

Imbalance and toxicity

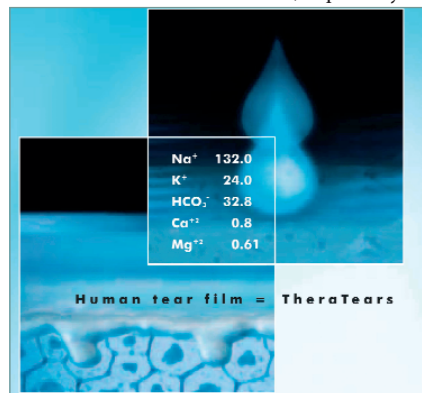
Conversely, an imbalance of electrolytes in the tear film is associated with what can be called 'electrolyte imbalance toxicity'. For example, toxicity caused by preservative-free sodium chloride solution has been demonstrated in rabbit eyes and in tissue culture⁴⁻⁶.

The toxicity caused by an electrolyte imbalance causes the same changes that are seen in dry eye disease, i.e. increased corneal epithelial cell desquamation and loss of conjunctival goblet-cell density. The signs and symptoms of electrolyte imbalance toxicity are therefore indistinguishable from those of dry eye.

The good news is that using better-balanced lubricant eye drops helps to restore the ocular surface. In the 1980s, Wilson, O'Leary and Bachman found they could decrease the corneal desquamation caused by preservative-free sodium chloride by adding certain electrolytes to the solution⁷.

Electrolytes as a catchphrase

Given the importance of electrolytes to the health of the ocular surface, it is not surprising that many companies now compete by touting the electrolyte composition of their products. However, all formulations are different, especially in



terms of their electrolyte composition. Some have little or no electrolyte content, and even those companies that make a serious attempt to duplicate the electrolyte balance of healthy tears only approximate these concentrations.

In an independent clinical study⁸, TheraTears™ was shown to restore conjunctival goblet cells in dry eye seen after LASIK vision correction surgery. Patients were treated with the TheraTears solution at least four times a day and, at night, one drop of a 1% CMC solution was applied. Controls were treated with a preservative-free balanced salt solution. At one week and one month, respectively, 87.5% and 100% of TheraTears-treated patients were free of dry eye symptoms, while only 12.5% and 20% of control-treated patients were symptom free. When the authors looked at goblet cell density by impression cytology after one month of treatment, the TheraTears solution was shown to significantly restore conjunctival goblet-cell density while treatment with preservative-free control did not.

Two subsequent studies^{9,10} found that patients who started using TheraTears about one week before LASIK surgery saw better faster, and felt more comfortable than those who did not.

Summary

Peer-reviewed studies and other clinical studies have shown that matching the electrolyte balance of the human tear film allows for an increase in conjunctival goblet-cell density. If your patients are not getting satisfactory results from their lubricant eye drops, electrolyte imbalance could be part of the problem.

About the authors

Dr. Jeffrey Gilbard is an ophthalmologist who began his research program on dry eye in 1976 as a medical student at Columbia University. He developed the tear osmolarity test for dry eye and has since written over 40 original articles, reviews and book chapters on dry-eye disease. He is a Clinical Assistant Professor of Ophthalmology at Harvard Medical School and Founder & CEO of Advanced Vision Research. Dr. Dennis Pardo is a graduate of The New England College of Optometry. After completing a Primary Care Residency he joined the Faculty at NEWENCO as an Associate Clinical Professor. Dr. Pardo also holds a Master's degree in Public Health from Yale University School of Medicine. As Director of Professional Relations for Advanced Vision Research, Dr. Pardo lectures extensively on dry eye topics to eye care professionals and optometry students.