

Dry eyes - remarks on local therapy

Bo Hedqvist

Ögonspeglin AB, Järnhälsan, Göteborg, Sweden

Introduction

In order to choose a good tear substitute for the treatment of dry eyes, it is necessary to understand the fundamentals regarding composition, properties and functions of the tear film. I will start by discussing with you some of this before we turn our attention to the treatment with artificial tears.

The tear film has several unique properties and the exact composition and content of the tear film is not yet fully understood. This makes it virtually impossible to design a tear substitute that can adequately replace the tear film and all of its functions.

Properties of the human tears

One particularly intriguing property is viscosity. The tear fluid is what is referred to as a “non-newtonian” fluid, which means that the viscosity depends on the shear rate, which is the amount of movement in the fluid. The greater the shear rate, the lower the viscosity. The rationale of this is that the viscosity must be high enough to allow the tear film to maintain a continuous layer, covering the exposed area of the ocular surface (1). It must also allow the eyelids to rapidly move across the ocular surface without unnecessary dragging of the epithelium, which would be painful and considerably slow down the blinking movement of the eyelids.

The ion composition of the tear fluid is another challenge to the manufacturer of tear substitutes. It seems that a concentration of potassium ions around 17.0 mmol/L is important for the cornea (2). Some artificial tears on the market have a potassium concentration far too low to be adequate in this respect. Sodium bicarbonate is the physiological buffer system of the tear fluid and is very important for the cornea (3). Experimental studies have shown that defects in the corneal epithelium heal considerably faster in the presence of sodium bicarbonate (4). Sodium bicarbonate in water ionises into sodium and bicarbonate ions. Bicarbonate ions in water form carbonic acid and hydroxyl ions. Carbonic acid further forms CO₂ gas and water. It is very difficult to manufacture an artificial tear with adequate stability for the bicarbonate to survive shelf storage. There is only one tear substitute with a stable content of sodium bicarbonate on the market today (Bion Tears) and my clinical experiences suggest that this formulation is very efficient, especially when treating severe cases of dry eyes.

Underlying the tear fluid is a layer of mucus covering the somewhat rugged epithelial surface (5). The exact function of the mucin is not fully understood. Recent work suggests that Frank Holly's theory about the hydrophobic surface of the cornea that needs “wetting” in order for the tear fluid to form a continuous preocular film (6), is not the whole truth. The corneal surface is possibly not all that hydrophobic, and the surface tension of the corneal surface is very difficult to adequately measure (7). Nevertheless, a decent amount of mucus seems to be necessary for the tear film to maintain its integrity. Without mucin on the ocular surface, the tear film is very much more unstable and break up time (BUT) drops to very short values. On the other hand, in dry eyes there is a decreased turn over of fluid and mucus. The mucus, contaminated with lipids, is therefore accumulated in the lower fornix, where it gets highly viscous and some patients can actually pull long strands of mucin from their eyes and they experience distinct discomfort.

Therefore, when treating dry eyes with artificial tears, some of the things to consider are viscosity, ion composition and mucous properties but also the nature and concentration of any additives such as preservatives.

Clinical remarks on treatment

As always, the key to success in treatment is a carefully performed interview, given enough time for the patient to explain the symptoms adequately. Questions to ask are, among others: Is there a regular periodic difference in symptoms during the course of the day? Is there anything in particular that you have noted to aggravate the symptoms? Do you take any medication on a regular basis? What is your main occupation during the course of the day? Do you spend a significant amount of time working at a computer? If so, how is the CPU and the VDU arranged on your desk? Very often significant improvement of symptoms can be achieved simply by re-arranging the working environment, especially the lighting, arrangement of office furniture and the computer set-up (8-10). Far too often I see VDU:s placed on top of large CPU:s, which makes it necessary to gaze upwards. This widens the interpalpebral aperture, leading to an increased evaporation rate of the tear fluid. If working in an office with rather dry air, which is very common, a device for increasing the humidity of the air is of great value.

If the patient is on any anticholinergic medication, getting in touch with the patient's doctor might result in a beneficial change in the drug regiment (11).

I will in the following give some remarks on the treatment of dry eyes, but I will not mention any specific products or substances. The reason for this being that the situation as to available products undergoes rapid and repeated changes. On my web site on the Internet, I keep this information as up to date as I can as far as the Swedish market is concerned, and I will continuously give my personal remarks on the various products. So far, this information is presented in Swedish only. The URL is: <http://www.ogonspegeln.se/tearsubst.html>

It is often stated that the dryer the eyes are, the more viscous a tear substitute should be used. I don't find that this is necessarily so. In fact, a very viscous tear substitute can be most uncomfortable in some of these cases. The key to success in treating the severely dry eye is to administer the tear substitute frequently. This can be very cumbersome, but in many cases, there is no easier way.

In my experience it is rather unusual to find one product alone, that can sufficiently alleviate the symptoms. In most cases, a combination of different tear substitutes is necessary. Again, the key to success is a carefully performed interview. I give you one case, just as an example on how one can individually design a treatment regiment that works, even if it doesn't make the patient completely symptom-free. In most cases, this is simply not possible, but the importance of the extra effort that the doctor demonstrates in trying to find the right treatment can't be emphasised enough.

A case description

This is a woman in her forties. She wakes up with very uncomfortable eyes indeed. The eyelids feel like "glued" on to the eyes and it is very painful to open the eyes. At work her eyes burn and sting when she works at her computer at the office. Later in the afternoon, the eyes feel somewhat better, but when watching TV in the evening she experiences an itching, burning sensation and her vision is slightly blurred. After going to bed and having put the lights out, she can actually feel her eyeballs burning against the closed eyelids.

This patient is probably best treated with an ointment at bedtime that will increase lubrication between the eyelids and the eye during sleep when the tear secretion is known to decrease even in normal eyes. On waking up in the morning, she should use a gel formulation, like polyacrylic acid that will lubricate and at the same time provide the necessary moisture. This can be combined with hypotonic saline drops (0.5%) in order to decrease the osmolarity of the tear film, which is often increased (12, 13). During work at the office she will certainly need frequent administration of a tear substitute that are not too viscous, and with a refractive index as close to natural tears as possible. This is important to avoid blurring of the vision that can otherwise be very bothersome during work.

Sometimes during the day, she takes her hypotonic saline drops. Later in the afternoon and during the evening she continues the daytime drops but now she takes the hypotonic saline drops together with the tear substitute even more often. Before going to bed, she takes the polyacrylic acid gel and just before putting the lights out, she takes the ointment.

This is one example of how a treatment regiment can be designed, and it shows just how much trouble patients with severely dry eyes are prepared to endure in order to find some relief. I would say that this particular patient administers something into her eyes at least 50 times each day. This situation is not uncommon and many patients take eye drops as often as every 10-15 minutes whenever awake.

Preservatives

When considering a tear substitute, close attention must be paid to the composition of the formulation. Not only the ion contents but also the presence of additives such as preservatives. Most preservatives are, in various degrees, toxic to the epithelial cells (14-19) and disrupt the lipid layer of the tear film (20), thus making the tear film even more unstable and can aggravate the damage caused by the disease to the ocular surface. Other adverse effects of preservatives are: disruption of intracellular desmosomes, increasing the corneal permeability (21-23), decreasing the activity of Lysozyme in the tear fluid (24), and sensitisation with risk for ocular allergy (25-27).

Based on these evidences, it is my strong belief that preservatives should be avoided whenever possible. Patients with dry eyes that needs to administer eye drops more often than 3-4 times a day, should only use non-preserved eye drops, preferably in single-dose containers.

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