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Hyperosmolarity of the tear film in dry eye syndrom.

The biophysical factors that dictate hyperosmolarity and the observed patterns of tear film break-up in dry eye are poorly understood and are difficult to interrogate experimentally, highlighting the need for mathematical and computational modelling in this field. We have examined a model incorporating the influence of polar lipids overlying an aqueous layer, while tracking the evolution of osmolarity. Our strategic objective was to identify factors which may influence the risk of developing or exacerbating dry eye as well as exploring how such factors differ between evaporative dry eye and aqueous tear deficient dry eye. In particular, we focus on the dynamics of the solute concentration for the duration of a single blink and interblink. Our mathematical model tracks the thickness of the aqueous layer, the concentration of the polar lipid, together with the concentration of the solute. Firstly, we have observed that tear film osmolarity is very sensitive to the evaporation rate, with salt concentrations readily exceeding irritation thresholds when using dry eye parameters. The results also highlight the importance of diffusion in reducing osmolar stress in the vicinity of black lines during the interblink. Nonetheless, in these regions diffusion is not sufficient to prevent potentially damaging osmolarities, especially as the evaporation rate is increased (constituting evaporative dry eye) or the tear volume is decreased (i.e. aqueous deficient dry eye). Simulations also indicate that saccades (rapid eye movements) could have a positive effect on osmolarities in the vicinity of the black lines.