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Dynamics of Fluorescent Imaging in Glob-Driven Breakup

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The tear film is the very thin film (3μm) left behind after a blink. The dynamics of tear film breakup (TBU) is important for understanding Dry Eye Syndrome (DES), which affects millions, and can help clarify the mechanisms of DES for ophthalmologists. Recently, a different type of breakup is observed, where tear film breakup (TBU) happens under or around a thick circular area of lipid in a second after blink; the thick lipid corresponds to a glob. Evaporation alone is too slow to offer a complete explanation of this type of breakup. Instead, a divergent flow driven by Marangoni effect is proposed to explain the rapid thinning. We examined the Marangoni-driven TBU hypothesis in a one dimensional and an axisymmetric models by assuming the thick lipid (glob) has higher surfactant concentration, thus a lower surface tension. In both models, the thick lipid spreads out immediately due to Marangoni effect, subsequently, a strong outwards flow dragged by the corresponding shear stress leads to TBU within a second. In addition, transport of osmolarity and fluorescein are also studied in the models. TBU happens while a weak osmotic flow flows across the ocular surface. The distribution of salt irons and fluorescein can be affected by the evaporation but are mostly determined by the Marangoni flow. The models predict that smaller globs or thinner film will decrease TBU time (TBUT). TBU will be seen under the glob, when glob is small, otherwise TBU occurs outside the glob. This study will help provide insights about mechanism of rapid thinning and how the properties of the glob will affect TBUT and visualization of TBU.