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Modified Model for UV-Laser Corneal Ablation

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Abstract : Laser corneal reshaping has been proposed as a successful treatment of many refraction disorders. However, some physical and chemical demonstrations of the laser effect upon interaction with the corneal tissue are still not fully explained. Therefore, different computational and mathematical models have been implemented to predict the depth of the ablated channel and calculate the ablation threshold and the local temperature rise. In the current paper, we present a modified model that aims to answer some of the open questions about the ablation threshold, the ablation rate, and the physical and chemical mechanisms of that action. The proposed model consists of three parts. The first part deals with possible photochemical reactions between the incident photons and various components of the cornea (collagen, water, etc.). Such photochemical reactions may end by photo-ablation or just the electronic excitation of molecules. Then a chemical reaction is responsible for the ablation threshold. Finally, another chemical reaction produces fragments that can be cleared out. The model takes into account all processes at the same time with different probabilities. Moreover, the effect of applying different laser wavelengths that have been studied before, namely the common excimer laser (193-nm) and the solid state lasers (213-nm & 266-nm), has been investigated. Despite the success and ubiquity of the ArF laser, the presented results reveal that a carefully designed 213-nm laser gives the same results with lower operational drawbacks. Moreover, the use of mode locked laser could also decrease the risk of heat generation and diffusion.

Keywords : UV lasers, mathematical model, corneal ablation, photochemical ablation
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