Transdermal delivery of macromolecules by erbium:YAG laser

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Abstract

The aim of this study was to assess the effect of molecular weight (MW) on the transdermal delivery of macromolecules by erbium:yttrium-aluminum-garnet (Er:YAG) laser treatment. Fluorescein isothiocyanate (FITC)-labeled dextran (FD) of increasing MWs (4.4, 19.4, 38, and 77 kDa) was used as the model macromolecules to investigate the skin permeation in vitro. Fluorescence microscopy and scanning electron microscopic (SEM) images were utilized to examine the transport mechanisms of the macromolecules via the skin after laser treatment. The results indicate a significant increase in the permeation of FITC and FD across skin treated by the laser. The MWs of macromolecules and laser fluences were found to play important roles in controlling macromolecular absorption. Transdermal delivery of FD with a MW of at least 77 kDa could be achieved with laser treatment. Follicular routes were significant for FITC permeation, whereas intercellular pathways played important roles on the delivery of FD. Ablation of the stratum corneum (SC) layer, photomechanical stress on intercellular regions, and alterations of the morphology and arrangement of corneocytes are possible mechanisms of how the Er:YAG laser promotes macromolecular delivery. No alteration of viable skin morphology was observed after laser treatment and the partly ablation of the SC may be reversible. Hexameric insulin showed higher skin permeation than did FD with similar MWs (38 kDa) with laser enhancement. From the study presented herein, it is concluded that the Er:YAG laser can be effective for transdermal delivery of macromolecules and hydrophilic permeants such as peptides and protein-based drugs.