The fractional laser-induced coagulation zone characterized over time by laser scanning confocal microscopy—A proof of concept study.


ABSTRACT

BACKGROUND: Ablative fractional laser (AFXL) is an acknowledged technique to increase uptake of topical agents in skin. Micro thermal ablation zones (MAZs) consist of ablated vertical channels surrounded by a coagulation zone (CZ). Laser scanning confocal microscopy (LSCM) images individual MAZs at 733 nm (reflectance confocal microscopy (RCM)). Further, LSCM can image sodium fluorescein (NaF) fluorescence with 488 nm excitation (fluorescence confocal microscopy (FCM)), a small hydrophilic test molecule (370 MW, log P -1.52), which may simulate uptake, bio-distribution and kinetics of small hydrophilic drugs. OBJECTIVES: To explore LSCM for combined investigations of CZ thickness and uptake, bio-distribution and kinetics of NaF in AFXL-exposed skin. STUDY DESIGNS/METHODS AND MATERIALS: Excised human abdominal skin samples were exposed to AFXL (15 mJ/microbeam, 2% density) and NaF gel (1000 µg/ml, 10 µl/cm²) in six repetitions, including untreated control samples. CZ thickness and spatiotemporal fluorescence intensities (FI) were quantified up to four hours after NaF application by RCM and FCM. Test sites were scanned to a depth of 200 µm, quantifying thickness of skin compartments (stratum corneum, epidermis, upper dermis), individual CZ thicknesses and FI in CZ and surrounding skin. RESULTS: RCM images established skin morphology to a depth of 200 µm. The CZ thickness measurements were feasible to a depth of 50 µm, and remained unchanged over time at 50 µm (P > 0.5). FI were detected to a depth of 160 µm and remained constant in CZ up to four hours after NaF application (15 minutes: 79 AU (73-92 AU), 60 minutes: 72 AU (58-82 AU), four hours: 78 AU (71-90 AU), P > 0.1). In surrounding skin, FI increased significantly over time, but remained lower than FI in CZ (15 minutes: 21 AU (17-22 AU), 60 minutes: 21 AU (19-26 AU), four hours: 42 (31- 48 AU), P = 0.03). AFXL-processed skin generated higher FI compared to non-laser processed skin in epidermis and upper dermis at 60 minutes and four hours (P = 0.03). CONCLUSIONS: By LSCM, assessment of the AFXL-induced CZ thickness was feasible to a depth of 50 µm, and assessment of FI from a small hydrophilic test molecule, NaF in CZ and surrounding skin feasible to a depth of 160 µm. Lasers Surg. Med. 50:70-77, 2018. © 2017 Wiley Periodicals, Inc. © 2017 Wiley Periodicals, Inc.

KEYWORDS: Fluorescence confocal microscopy; fluorescence intensity; imaging; micro thermal ablation zone; reflectance confocal microscopy; sodium fluorescein; topical drug delivery

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