FACTORS AFFECTING HISTOLOGIC DEPTH OF PENETRATION IN NEEDLING- AND LASER-ASSISTED DRUG DELIVERY

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Background: Needling- and laser-assisted drug delivery are emerging techniques to treat scars, aging skin, and actinic keratoses. It is unknown how the timing of topical drug application, before versus after needling/laser treatment, affects the depth of penetration. We conducted an ex-vivo study to compare the histologic depth of penetration among microneedling, roller needling, and CO_2 laser treatments both before and after application of ink.

Study Design/Materials and Method: Excess skin harvested from abdominoplasties was tested with: (A) Ink and consecutive microneedling, roller needling, or CO_2 treatment at 30 min, 1 hour, 2 hours, 3 hours, 4 hours, and 6 hour increments. (B) Microneedling, roller needling, or CO_2 treatment and consecutive ink application at 30 min, 1 hour, 2 hours, 3 hours, 4 hours, and 6 hour increments. The specimens were stained with hematoxylin and eosin, and histologic depth measured.

Results: Ink applied before microneedling reached the greatest mean depth of penetration when compared to ink applied after the microneedling as well as any treatments with roller needling or CO_2 laser ($P < 0.05$). Furthermore, there was a time-dependent increase in penetration that plateaued at 3 hours with microneedling. Conversely, there was a time-dependent decrease in penetration with CO_2 laser.

Conclusion: Ink applied before microneedling exhibited the greatest depth of penetration compared to treatment with roller needling or CO_2 laser. The depth of penetration is time-dependent with microneedling and plateaus around 3 hours.

Clinical Applications – Cutaneous – *Novel Use Of Lasers For Medical Conditions*

CLINICAL ASSESSMENT OF A REAL TIME, NON-INVASIVE, *IN VIVO* SKIN CANCER DIAGNOSTIC DEVICE BASED ON LASER SPECTROSCOPY AND DEEP LEARNING ALGORITHM USING AESTHETIC LASERS

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Background: There have been several optical-based techniques for *in vivo* skin cancer detection and screening such as multi-spectral imaging and Raman spectroscopy. However, they adopt high cost lasers and imaging sources and have relatively insufficient accuracies for actual clinical use. In this study, a real time, non-invasive, *in vivo* skin cancer diagnostic device has been developed with high diagnostic accuracy based on non-discrete molecular laser induced breakdown spectroscopy (LIBS) and deep learning algorithm using pre-existing aesthetic lasers as its excitation sources.

Study Design/Materials and Method: A single-site study was designed to evaluate the effectiveness and safety of the aforementioned diagnostic device. A conventional Q-switched 1064 nm laser was used to induce micro plasma from the suspicious skin lesion. Real-time analysis was performed on the plasma light spectrally, to extract elemental and molecular information of the suspicious lesions. The algorithm was validated by collecting and assessing emission spectra from 33 skin cancers and 55 benign lesions on 29 subjects. Three different laser irradiations were applied to each lesion and the corresponding spectra were averaged for the analysis of each lesion.

Results: Algorithmic analysis is the process of comparing the acquired spectra to a previously collected spectral database (derived from 5302 emission spectra of cancerous and benign lesions) and determining similarities. Device results were compared with the histopathology results. Analysis achieved a sensitivity of 97.0% and specificity of 87.3% in discriminating skin cancers from benign lesions in a blind setting.

Conclusion: A novel skin cancer diagnostic device based on non-discrete molecular LIBS and deep learning algorithm demonstrated to be a promising, low-cost tool for the detection of skin cancers with superior diagnostic accuracy compared to other previous optical-based diagnostic techniques.

Clinical Applications – Cutaneous – *Pigment*

BIOLOGICAL EFFECT OF A HIGHLY FOCUSED, SCANNED, NEAR-INFRARED LASER ON DERMAL PIGMENT

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Background: Selective photothermolysis relies on absorption of light by a target along with the proper choice of pulse duration to achieve selectivity. However, absorbing structures above or below the target in the skin are also affected as evidenced by treatments on dark skin type patients, where the epidermis becomes the unintended target. A novel device was developed which enables three-dimensional spatial placement of the treatment zone in tissue, creating high fluence in a localized region at the intended depth in skin while minimizing the fluence in other regions.

Study Design/Materials and Method: We developed an animal model of hyperpigmentation by tattooing a light-skinned Yucatan pig with a synthetic melanin tattoo. Treatments were performed on the tattooed areas with a prototype laser based on a high numerical aperture focused, scanned 1064 nm Q-switched fiber laser. Biopsies were taken before and immediately post-treatment. Fontana Masson-stained histology and electron microscopy of the tissue sections before and after treatment were compared. Treatments were also performed on stable PIH on the back of a skin type IV human subject, and biopsies were taken. Histology with H&E, Fontana Masson, and TUNEL (apoptosis detection) staining were compared between an untreated control and the treated lesion.

Results: Fontana Masson stained histology of the tattooed pig showed the presence of dermal melanin, validating the animal PIH model. Electron microscopy of the pig skin showed destruction of melanin-containing macrophages in the dermis post-treatment and no damage to tissue in the immediate vicinity. TUNEL-stained histology on human PIH lesions showed apoptosis in the melanin- containing cells in the dermis but no injury to the epidermis.

Conclusion: The new 3D spatially selective laser platform has been shown to allow precise targeting of tissue structures in the treated volume of the skin while sparing tissue around it. It