assumes that heat propagates with infinite velocity. Alternatively, a hyperbolic heat conduction equation may be used to account for finite velocity heat propagation. The objectives of this investigation are to: (1) study the effects of temporal and radial variations of CSC boundary conditions on epidermal protection, and (2) compare predictions from parabolic and hyperbolic heat conduction models.
Study Design/Materials and Methods: Finite element is used to solve light and heat transfer (parabolic and hyperbolic) equations with varying boundary conditions on a skin cross section. An Arrhenius kinetic model is used to assess thermal damage.
Results: Temperature profiles show that epidermal protection is only uniform within a 2 mm radius of the sprayed surface. By the periphery of the sprayed area, epidermal absorption increases and blood vessels are not photocoagulated. Temperature dynamics show that there are differences in the heat propagation between parabolic and hyperbolic models.
Conclusions: Variations in boundary conditions and choice of mathematical model must be considered and ideally controlled to optimize current laser therapies.

Note1: I am applying for a Post-Doctoral Fellow Award.

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BIOHEAT TRANSFER IN LAYERED SKIN MODEL SUBJECTED TO SHORT PULSE LASER IRRADIATION

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Background and Objectives: Over the last few years, short pulsed lasers are increasingly being used in dermatological applications like tissue welding/soldering and photo-rejuvenation. The objective of this study is to analyze the axial and radial temperature distributions in tissue phantoms and animal tissue samples irradiated with a short pulse laser source. Traditional Fourier heat conduction model, which implies an infinite speed of propagation of heat, is used to model such phenomena. In this paper, hyperbolic non-Fourier heat conduction formulation is used and compared with the Fourier model.
Study Design/Materials and Methods: A multi-layered model of skin consisting of the outer skin layer (epidermis), the lower layer (dermis), and fatty tissues underneath is considered. A mode-locked Argon Ion pulsed laser is used as radiation source; temperature distributions on the surface and within the skin layer are recorded using a thermal imaging camera and thermocouples, respectively. Numerical and experimental studies are performed with variation of different parameters such as pulse train frequency, pulse width, laser power and blood perfusion rates.
Results: The experiment performed demonstrates that short pulsed laser heating results in a lower heat affected zone compared to a continuous wave source. Experimentally measured temperature profiles match the prediction from the non-Fourier model compared to the Fourier formulation, particularly for times less than the relaxation time of tissues. At larger times, both Fourier and non-Fourier converge to the same values.
Conclusion: This work demonstrates that short pulsed laser heating is suitable for dermatological applications where minimal damage to the surrounding tissue is of importance. Also, it can be concluded that alternative non-Fourier model is a more accurate representation in predicting temperature distributions and tissue thermal damage than the traditional Fourier model.

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EXCIMER LASER ENERGY INDUCES THROMBOLYSIS WITH LESS DEBRIS AT LOWER ENERGIES

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Background and Objective: Excimer laser has been shown to be an effective method for removal of arterial thrombus. We evaluated the effect of laser catheter size and energy parameters on thrombolysis and thrombotic debris production.
Study Design/Materials and Methods: Fresh fibrin rich thrombi were made in tubes using rabbit whole blood (10 ml) after adding fibrinogen (5 mg/ml), thrombin (0.3 units/ml), $CaCl_2$ (1.5 mg/ml) and incubated at 4°C overnight. Lasing (308 nm) was delivered with varying catheter diameters (0.9, 2.0 mm) and laser energies (0–35 mJ). Debris generated by lasing was ejected by flushing with normal saline. Debris was dried at 70°C and weighed.
Results: Higher laser energy induced more thrombolysis and produced more debris. There was strong correlation between energy and thrombus debris ($r = 0.91$; $p < 0.02$).

Sample (n)	6	6	4	3	6	6	3
Energy (mJ/pulse)	35	28	20	0	7	5	0
Catheter Diameter	2 mm	2 mm	2 mm	2 mm	0.9 mm	0.9 mm	0.9 mm
Thrombus Lysis (g)	0.2 ± 0.03*	0.18 ± 0.04*	0.18 ± 0.02*	0.12 ± 0.04**	0.15 ± 0.03**	0.16 ± 0.02**	0.11 ± 0.04**

$p < 0.05$: * vs. **

Conclusions: Excimer laser can provide an alternative in patients with contraindications for systemic thrombolytic agents or GP IIb/IIIa antagonists. However, lower energies and smaller catheters produce less thrombolysis and debris.