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Is photoacoustic imaging clinically safe: evaluation of possible thermal damage due to laser-tissue interaction

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Photoacoustic imaging is a breakthrough imaging modality that combines the spatial resolution of ultrasound imaging with the contrast of optical imaging. This imaging technique is being pushed towards clinical acceptance for many applications, such as noninvasive diagnosis and management of a multitude of neoplastic lesions. However, a rigorous evaluation of the tissue thermal response to the laser illumination is required prior to the clinical translation. In this study, we assessed the temperature rise profile and microstructural damage of the skin due to the laser-tissue interaction using *in-vivo* mouse models. We compared the effect of two different laser frequencies (10 Hz and 30 Hz) on the skin and studied if the use of a cooling method could be clinically useful in preventing tissue necrosis. Two biopsies were taken from each mouse 48 hours after laser exposure; one from the skin directly exposed to the laser and one from neighboring healthy tissue. When the lower frequency laser was used, no necrosis was found on histologic analysis. However, when the higher frequency laser was used, necrosis was noted in the epidermis, dermal collagen, and hair follicles at the site of laser exposure. Use of the cooling method with the higher frequency laser led to no tissue necrosis. Overall, it appears that photoacoustic imaging is likely safe when lower frequency lasers are used, and the implementation of the cooling method seems to mitigate necrosis when the use of a higher frequency laser is warranted. This opens up exciting new possibilities for a noninvasive way of diagnosing and evaluating a variety of lesions, including malignant tumors. However, some further studies are needed before photoacoustic imaging can be clinically used in human subjects.