

Utilizing biopsy-free virtual histology for improved clinical efficiency in the dermatologic surgical setting

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Abstract:

The ability to accurately define tumor margins may enhance tissue sparing and increase efficiency in the dermatologic surgery process, but no device exists that serves this role. Reflectance Confocal Microscopy (RCM) provides non-invasive cellular resolution of the skin. The only clinically-approved RCM device is bulky, non-portable, and requires a tissue cap which makes mapping of the underlying tissue impossible. We recently combined “virtual histology”, a machine learning algorithm with RCM images from this standard RCM device to generate biopsy-free histology to overcome these limitations. Whether virtual histology can be used with a portable, handheld RCM device to scan for residual tumor and tumor margins is currently unknown. We hypothesize that combining a handheld RCM device with virtual histology could provide accurate tumor margin assessment. We determined whether our established virtual histology algorithm could be applied to images from a portable RCM device and whether these pseudo-stained virtual histology images correlated with histology from skin specimens. The study was conducted as a prospective, consecutive non-randomized trial at a Veterans Affairs Medical Center dermatologic surgery clinic. All patients greater than 18 years of age with previously biopsied BCC, SCC, or SCCis were included. Successive confocal images from the epidermis to the dermis were obtained 1.5 microns apart from the handheld RCM device to detect residual skin cancer. The handheld, in-vivo RCM images were processed through a conditional generative adversarial network-based machine learning algorithm to digitally convert the images into H&E pseudo-stained virtual histology images. Virtual histology of in-vivo RCM images from unbiopsied skin captured with the portable RCM device were similar to those obtained with the standard RCM device and virtual histology applied to portable RCM images correctly correlated with frozen section histology. Residual tumors detected with virtual histology generated from the portable RCM images accurately corresponded with residual tumors shown in the frozen surgical tissue specimen. Residual tumor was also not detected when excised tissue was clear of tumor following surgical procedure. Thus, the combination of virtual histology with portable RCM may provide accurate histology-quality data for evaluation of residual skin cancer prior to surgery. Combining machine learning-based virtual histology with handheld RCM images demonstrates promise in providing insights into tumor characteristics and has the potential to assist the surgeon and better

guide practice decisions to more efficiently serve patients, leading to decreased layers and appointment times. Future work is needed to provide real time virtual histology, convert horizontal/confocal sections into vertical or 3D sections, and to perform clinical studies to map tumors in tissue.

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