IN-VITRO VALIDATION AND QUANTITATIVE MEASUREMENTS OF GRADED BURN WOUNDS ON A PORCINE MODEL USING HANDHELD LASER SPECKLE IMAGING

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Burn wound severity can be difficult to assess and the diagnosis is usually subjective. Optical techniques have emerged as alternative methods for providing objective, non-contact assessment of burn wound severity. One such technique is Laser Speckle Imaging (LSI), which quantifies superficial blood flow using coherent laser light. We have previously demonstrated that LSI can be used to accurately assess burn wounds. However, LSI is conventionally used in static designs, such as cart-based or tripod mounted configurations, due to the susceptibility of LSI to motion artifact. This can limit the portability and usability of the device in a clinical. Handheld LSI can potentially overcome these limitations. However, accounting for motion artifact associated with user movement must be addressed to obtain accurate and reliable blood flow measurements.

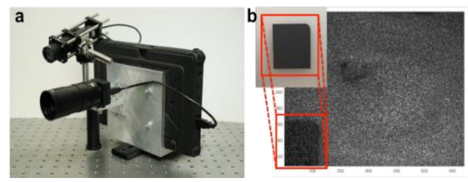

Figure 1 – a) Handheld LSI Device and b) Fiducial Marker

We first created a handheld LSI device and incorporated a fiducial marker for data acquisition (Fig.1). The use of the fiducial marker is unique because it allowed the sorting of images based on amount of motion artifact and image alignment in each data set. To test the accuracy of handheld LSI with our fiducial marker technique, we performed in vitro and in vivo validation experiments, and compared the results to standard mounted configuration. In vitro validation was performed using varying flow speeds (0-5 mm/s) of an intralipid solution in a silicone flow phantom. In vivo validation measurements were taken on a porcine model (n=2) with histologically verified graded burn wounds ranging in severity from superficial to full thickness. For both validation experiments, we used the fiducial marker to identify the 10 images with the highest speckle contrast (K) within each data set. These 10 images correspond to the images with the least motion artifact and were used for alignment prior to region of interest selection and K quantification. The K flow values obtained using the mounted and handheld configurations from the in vitro experiment differed by <5% when using the fiducial marker correction technique (Fig. 2). Using the fiducial marker for motion artifact correction in in vivo measurements, K flow values of the mounted and handheld for each burn site varied by <8% (Fig. 3). Without using the fiducial marker for image alignment, flow quantification was not reliable. We were able to show the use of a fiducial marker during data acquisition makes handheld LSI practical, with results comparable to when the device was mounted conventionally on a stationary object. The results show the potential of handheld LSI as a substitute for conventional LSI.Further work using the handheld LSI device with fiducial marker will be completed to decrease the difference in flow values measured through additional data collection and processing improvements. The work of this project is relevant to the Optics, Biophotonics, and Medical Imaging themes of ECI. We are trying to expand upon a currently used imaging modality by introducing new methods for clinical imaging.

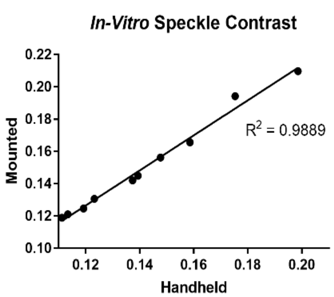

Figure 2 - Speckle Contrast Values within Flow Region Using Mounted and Handheld Setup. Flow speeds between 0-5 mm/s.

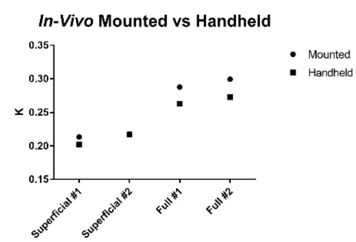

Figure 3 - Mounted and Handheld Speckle Contrast Measurements of Superficial and Full Thickness Burns