burn wounds, and peak edema tends to reach higher levels. However, little is known about the differences that may exist between a superficial and a deep partial-thickness injury. In this study, both burn types show high levels of water, but the deep partial-thickness wounds actually showed a 23% increase in water concentration compared with 18% in superficial partial-thickness burn wounds. The fact that superficial partial-thickness burns had less water than deep partial-thickness burns might suggest that superficial burns start the resorption process earlier or do not accumulate the same amount of edema as their deepcounterpartsatthistimepoint. Thisissecondary to an intact lymphatic system that can resorb the accumulated edema fluid more rapidly. This finding is consistent with the literature, because full-thickness injuries do not resorb edema fluid as quickly with high levels of edema remaining at 48 hours, and 25% of the edema still remain 1 week after injury. Deep partial-thickness burn wounds seem to behave in the same manner with a limited capacity to resorb edema fluid quickly.

Water content in the burn wound varied depending on the detector position. The detectors are organized strategically to collect transmitted light from certain regions of the skin and subcutaneous tissue. Detectors 1 and 2 are the superficial and deep dermal detectors. Detector 3 is the subcutaneous tissue detector. Overall, the superficial detector showed less water content (15%) compared with the deeper tissue detectors (23%). This suggests that a greater amount of edema forms in the subcutaneous tissue, when compared with the dermis. Papp et al used the dielectric constant to show in a porcine burn model that water content was increased in the subcutaneous fat over the other skin layers and compared with preburn levels. The greatest increase in subcutaneous water content was found in the partial-thickness injuries compared with the superficial- or full-thickness burns. Therefore, the increase in water concentration in the subcutaneous layer may be an important differentiating feature of burn depth.

This study represents our preliminary clinical experience with the NIR technology. There are several limitations of this study. The small sample population samples size reflects the nature of a pilot study. Our aim was to prove or disprove that NIR spectroscopy has potential as a noninvasive measure of edema in a clinical environment. Large TBSA burns were excluded, because they are resuscitated with varying levels of fluids, and this would have had an impact on the amount of edema accumulation. Differences in edema formation could have then been attributed to the varying levels of fluid given and would have added a confounding variable. In this study, we wanted to establish baseline results in a nonfluid resuscitated patient population before adding variables into the data processing. Data were collected from the burn wounds and local controls at the time point, 48 hours after burn injury. This time point was chosen based on the referral patterns to our center for small TBSA injuries, and also, because at 48 hours, burn patients have reached their peak edema levels and should be in the plateau or the slow resorption phase. It is well known that edema formation is affected by time, burn depth, fluid resuscitation type, and volume, and our future work in this area will investigate these variables.

The study goal was to prove that NIR technology is capable of measuring water concentration and, therefore, edema. An additional finding from this study is the fact that edema levels could be used to differentiate partial-thickness injuries. This adds strength to our hypothesis that water content is an important variable when assessing burn depth using NIR spectroscopy and should be used in conjunction with oxyhemoglobin and deoxyhemoglobin variables. Future support for this statement comes from our early porcine burn studies, where a multivariate analysis using the three variables, water, oxyhemoglobin, and deoxyhemoglobin, dramatically improved the robustness of the NIR assessment of depth.

A noninvasive monitor of edema is instrumental in improving our knowledge of burn edema pathophysiology. Without this knowledge, it is difficult to monitor the effects of current or new therapeutics, thereby limiting potential advances in this area. NIR holds promise as a new noninvasive, portable clinical tool to quantify edema in vivo. A tool that has the capacity to measure edema possesses medical applications that extend well beyond the field of burn wound physiology.

REFERENCES
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