Assessment of Burn Injuries Using Hyperspectral Imaging

Jose L. Ramirez-GarciaLuna[1,2], Robert Bartlett[1], Amy Lorincz[2], Sheila C. Wang[1,2], Robert D. J. Fraser[2,3], Gennadi Saiko[1], Mario A. Martinez-Jimenez[4]

[1]McGill University Health Centre, Montreal, QC, Canada. [2]Swift Medical, Toronto, ON, Canada, [3]Arthur Labatt Family School of Nursing, Western University, Canada,

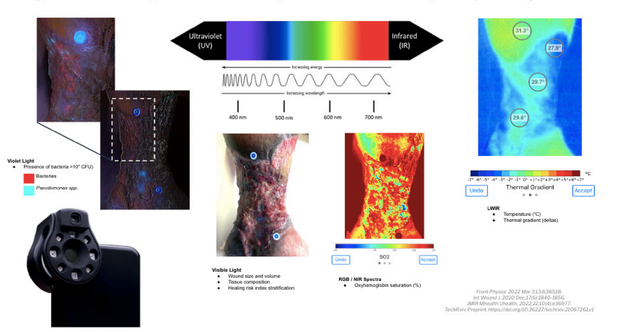
Objective

The objective of this study was to use a novel hyperspectral imaging device to assess burns and identify image patterns that correlate with the need for surgical management and higher graft survival.

Background

- Hyperspectral imaging (HSI) consists of the **simultaneous acquisition** of images at different wavelengths of the electromagnetic spectrum.
- HSI acquires a multi-dimensional image dataset (one dimension per specific wavelength) called a **hypercube** that provides diagnostic information about tissue physiology, morphology, and composition.
- Swift Medical's **Ray 1** HSI imaging device is the first pocket-size camera capable of acquiring a hypercube of wound images containing data on the presence of bacteria, size and tissue composition of wounds, oxyhemoglobin saturation, and thermal characteristics.
- Ray 1 can therefore be used for **assessing perfusion, inflammation, and the infectious status of a wound.**
- **Burns** are especially well suited for HSI imaging, as their management requires 1) identification of those injuries that require advanced management, including skin grafting, and 2) confirmation of a clean wound with a high healing potential before surgical treatments can be initiated.

- **The Swift Ray 1 HSI imaging device offers the capability of acquiring a hypercube image dataset. We hypothesized that the hypercube can be used to predict whether a burn will require surgical management or not.**



Methods

- **21 patients were imaged using the Swift Ray 1 <48h after the injury and after initial debridement**
- **Inclusion criteria:**
  - Partial to full thickness burns in <40% BSA
  - Admission into the burn unit within 24-48h after injury
- **Exclusion criteria:**
  - Significant comorbidities, BMI <19, documented infection
  - Foreign objects embedded in tissue
  - Gross oedema and systemic causes of hypoperfusion
- **The clinical team was blinded to the images.**
- **The patient's outcome was categorized as:**
  - Re-epithelization if the wound healed by secondary intention
  - Surgical management if a skin graft or a cellular tissue product was applied

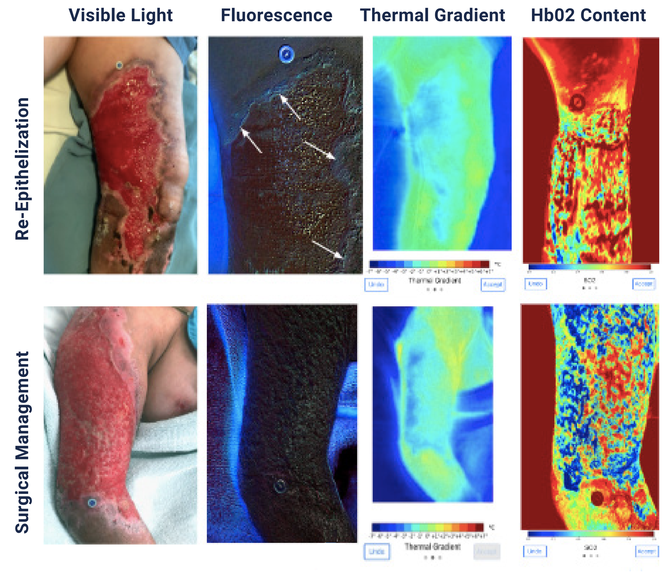
Results

Burn surface area, tissue composition (% of epithelium, granulation tissue, slough, and eschar), wound bed thermal gradient, presence of bacterial fluorescence, and mean HbO_2 saturation were recorded.

VARIABLE	RE-EPITHELIZATION (n = 12)	SURGICAL MANAGEMENT
AGE	26.0 ± 20.7	20.4 ± 19.1
MALE (%) FEMALE (%)	8 (66%) 4 (33%)	5 (55%) 4 (45%)
BSA (%)	23.6 ± 9.8	26.8 ± 6.1
BURN ETIOLOGY SCALD	9 (75%) 3 (25%)	3 (33%) 6 (66%)

Qualitative hypercube analysis

VARIABLE	RE-EPITHELIZATION	SURGICAL MANAGEMENT
TISSUE COMPOSITION	• More granulation tissue • Epithelial borders • Epithelium surrounding hair follicles	• Less granulation tissue • Deeper burns
THERMAL GRADIENT	• Hotter wound beds with a thermal gradient <3°C compared to that of uninjured skin	• Colder wound beds with a thermal gradient <5°C compared to that of uninjured skin
FLUORESCENCE IMAGING	• Absence of bacterial contamination • Epithelial border autofluorescence	• Absence of bacterial contamination
HbO_2 SATURATION	• Higher oxygen content	• Lower oxygen content • Areas of hypoxia



- HSI imaging of burns shows interesting insights into the **wound healing potential**
  - Burns with more **granulation tissue** and epithelial borders identified under visible light imaging, are more likely to heal by re-epithelization.
  - Fluorescence imaging confirms the **absence of bacterial contamination** in the early stages of burns. In wounds with high healing potential, this imaging modality also helps identify the **epithelial borders** (arrows) more easily, as they appear white under the violet light.
  - Thermal imaging shows **higher temperatures** in wounds likely to heal by re-epithelization.
  - Likewise, oxygen imaging **shows higher HbO_2 saturation** values in wounds with high healing potential.

Discussion

- Here, we highlight how the use of HSI imaging provides insight into burn healing outcomes.
- While more studies need to be done to analyze longitudinal data over an increased number of patients, this technology is a promising tool for developing predictive models and decision support systems for rationalizing burn care.
- Our goal is to finalize data collection and do a quantitative analysis of the data for developing decision systems.
- The Swift Ray 1 offers HSI imaging capabilities that allow clinicians to acquire images to complement their clinical assessments and enhance point-of-care clinical decision making. All images are acquired simultaneously and without the need for modifying ambient lightning.
- **In summary, along with clinical data, the use of the Swift Ray 1 HSI imaging device can help categorize burns as having a low or high healing potential; thus, helping clinicians make better decision making regarding their management and need for surgical care.**

References

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