Assessment of Hard-To-Heal Wounds using Hyperspectral Imaging

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SWIFT

Introduction

Objective

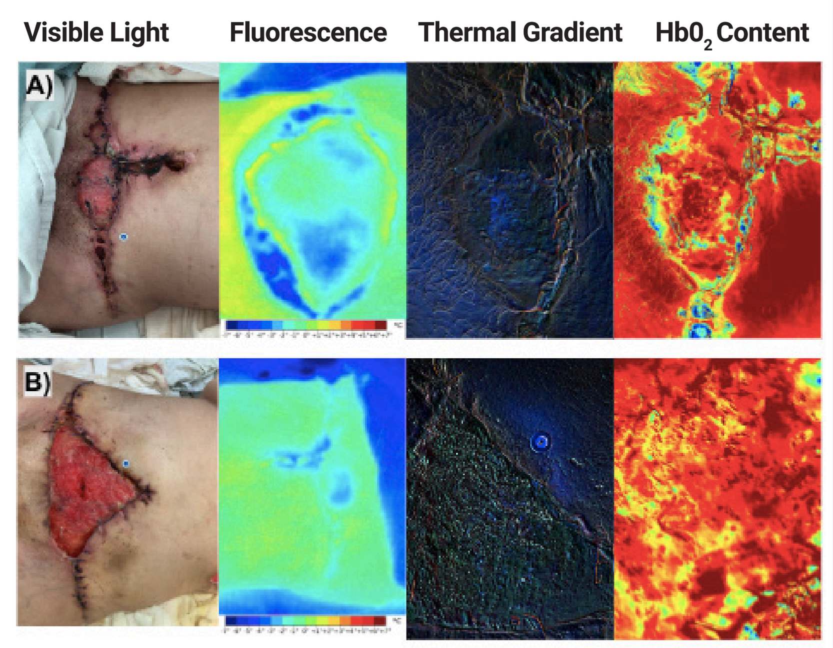
A series of three patients with hard-to-heal wounds were imaged using a hyperspectral imaging device. The ensuing images allowed the clinical team to understand the reasons for not healing and modify the treatment accordingly.

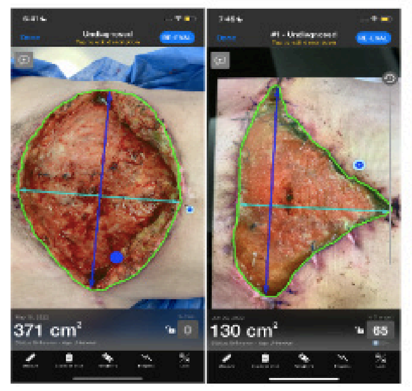
Background

- 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** is the first pocket-size camera capable of using HSI to aquire a hypercube of wound images containing data on the **presence of bacteria, size and tissue composition of wounds, oxyhemoglobin saturation, and thermal characteristics.**
- **The Swift Ray 1 can be used for assessing perfusion, inflammation, and the infectious status of a hard-to-heal wound; thereby, helping identify the cause of non-healing.**

CASE 1

- A 31-year-old female with post-surgical wound complications.
- The patient's history includes two c-sections 5 and 2 years before presentation. She recently had undergone an abdominoplasty and presented to our clinic because of dehiscence of the wound and suspected infection.
- On presentation, she had a very large open wound covering the surgical site and extensive skin necrosis. **HSI imaging ruled out the presence of infection** as no bacterial fluorescence nor inflammatory changes were identified (Panel A).
- Levine swabbing confirmed the absence of infection in the wound bed or its margins.
- **Assessment of tissue viability** with IRT and HbO_2 imaging suggested that no further necrosis would be expected.
- The patient was managed with NPWT. The Ray 1 with the rest of Swift Medical's wound management solution, allowing the accurate **3D reconstruction** of the wound and enabling volumetric measurements in it (for a video 3D rendering of the wound, scan the QR code).
- After 4 weeks of intermittent NPWT, the wound presented **significant improvement** and the wound was skin grafted (Panel B).
- Throughout the patient's wound journey, **HSI imaging helped monitor the lack of tissue bacterial contamination, tissue oxygen levels, and perfusion; paving the way for an efficient planning** of the surgical repair of the wound.





Initial Size   Final Size


Wound After Grafting

Initial Wound 3D Rendering

CASE 2

A 69-Year-Old woman with Type 2 Diabetes Mellitus and a Chronic Venous Ulcer.

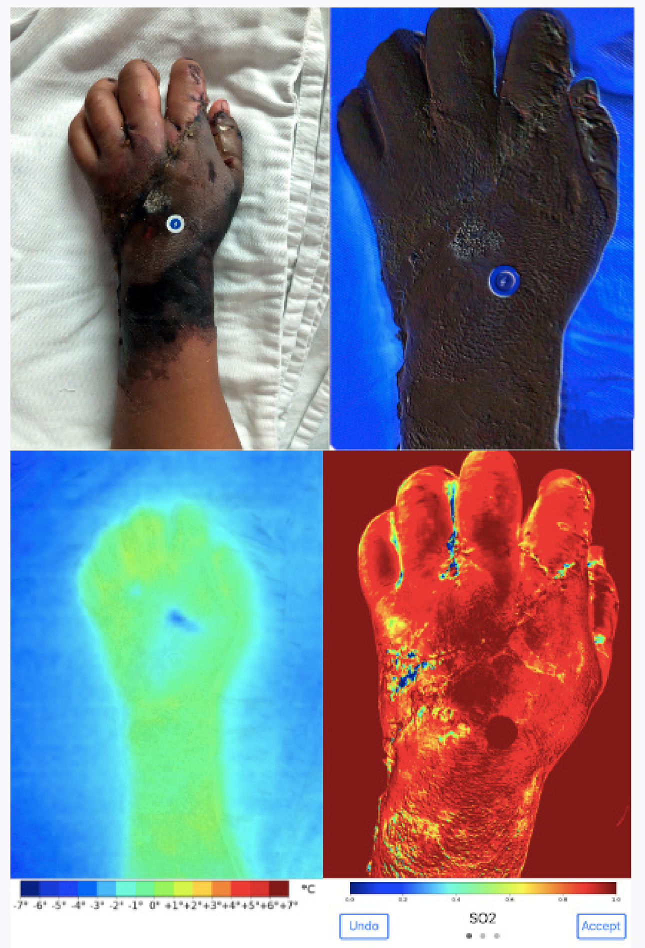
- The patient's ulcer had been present for 8 months. Despite compression therapy and sclerotherapy, the wound did not close and was sent to our wound clinic for assessment and management.
- On initial presentation, the wound presented necrotic borders and a large amount of slough over the granulation tissue; however, bacterial contamination was ruled out through violet light fluorescence. Infrared thermal imaging (IRT) demonstrated a cold wound bed, with a thermal gradient below -3°C, which indicates the **need for advanced management.** Oxyhemoglobin (HbO_2) imaging correlated the previous findings with a wound bed with relatively low oxygen content (Panel A).
- After debridement and preparing the wound bed for 15 days, the ulcer was grafted with autologous skin; however, the patient was lost to follow-up, as she lived in a rural community.
- 4-weeks later, she returned to our clinic because of pain and malodour in the wound. **Bacterial fluorescence imaging confirmed the presence of bacteria** below the graft and a targeted tissue biopsy was returned positive for E. coli infection. Nonetheless, HSI imaging showed areas of the **graft with high oxygen content** and temperatures similar to those of healthy skin so the decision to initiate antibiotics and save as much tissue as possible was done (Panel B).
- Resolution of the infection was monitored clinically and by HSI imaging (Panel C).
- After three weeks, HSI monitoring showed resolution of the infection and uptake of the remaining grafts, thus **avoiding additional surgical procedures** (Panel D).


Final Outcome

CASE 3

A 4-Year-Old Child with an electrical burn in the hand.

- Our wound care team was called for assessing the injuries on the left hand of a children who had sustained an electrical injury after inserting a for into a 110V electric outlet 48 hours ago.
- The child had been transferred from a primary care centre where initial assessment and repair of the wound was done.
- On clinical inspection, the skin on the dorsum of the hand was **charred**, particularly around the wrist, but pulses were palpable.
- HSI showed absence of bacterial contamination, and relatively homogeneous temperature gradient and oxygen saturation across the whole hand. Therefore, we concluded that the **tissue was viable** and that no further surgical care would be needed, namely tangential skin excision.
- The patient progressed adequately and was discharged 3 days later for follow-up in the outpatient clinic.

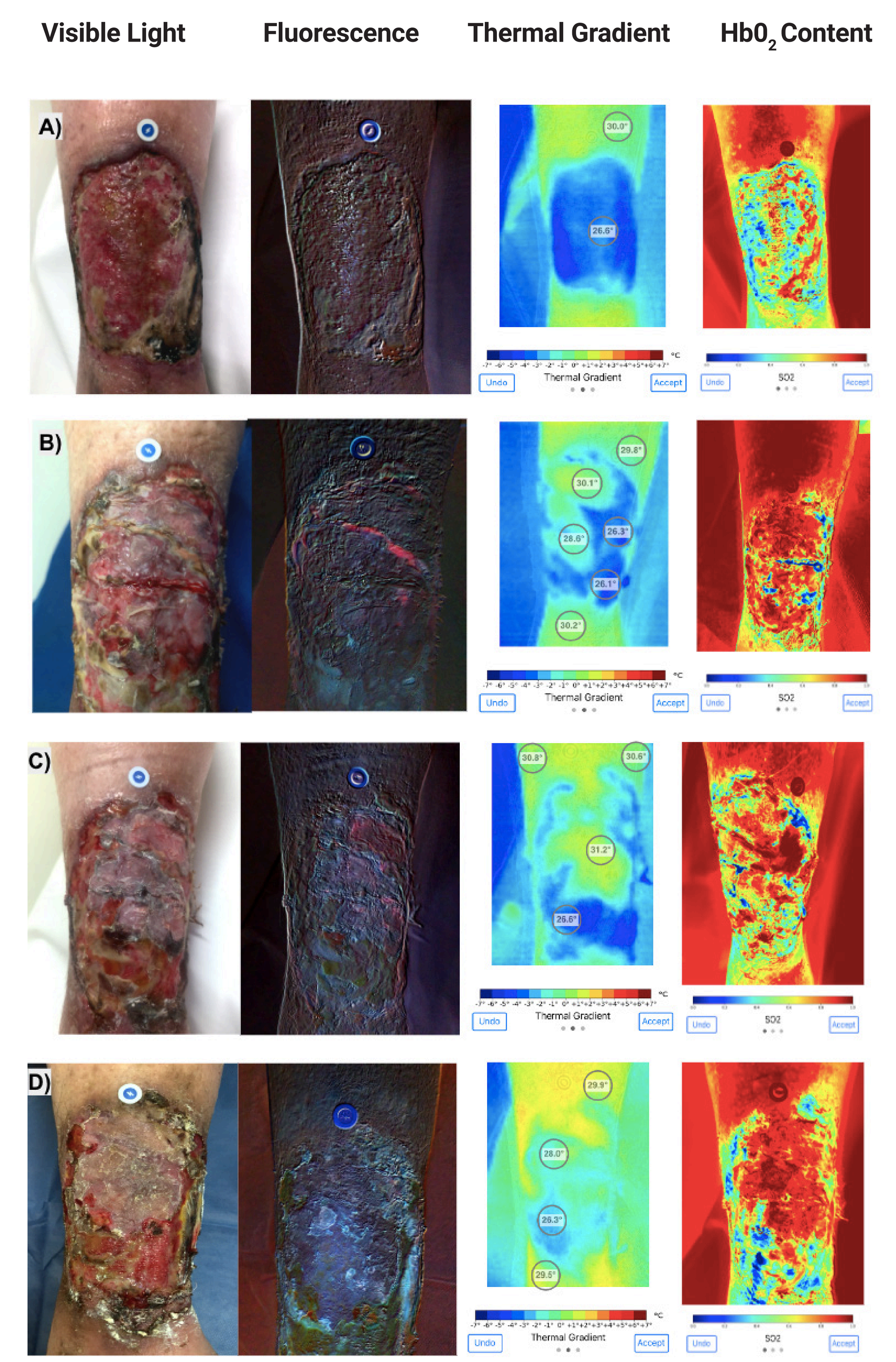


CONCLUSIONS

HSI is a **point-of-care imaging** technology that can easily be incorporated into wound care. HSI aids in **clinical decision making** by enabling more informed decisions and providing real-time feedback on tissue physiology and response to healing.

The Ray 1 device is currently the only HSI device that **simultaneously acquires visible light**, violet fluorescence, infrared, and near-infrared images as a hypercube; allowing the measurement of wound size, tissue composition, bacterial load, perfusion, and oxygenation.

CASE 2



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