Thermal Imaging Analysis of Affected Skin in Hidradenitis Suppurativa Patients Using Forward-Looking Infrared (FLIR) Technology: A Pilot Study

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Introduction

- Hidradenitis Suppurativa (HS) is a chronic inflammatory skin condition that is characterized by painful nodules, abscesses, and sinus tracts [1].
- Many patients progress to advanced stages of HS and require surgical intervention.
- There is no standardized imaging modality to confirm and identify the extent of affected skin, making it difficult to comprehensively resect HS [2].
- There is an element of subjectivity in mapping out the area of involvement for procedures[2].
- Thermal imaging using forward-looking infrared (FLIR) cameras provides a non-invasive approach to visualize areas of active inflammation using temperature measures to map out diseased areas.
- This pilot study aims to evaluate the utility of FLIR imaging in precisely mapping diseased skin in HS patients and to determine its impact on surgical planning and outcomes.

Methods

01 HS patients undergoing surgical excision were imaged pre- and post-operatively using standard photographs and FLIR imaging after acclimating to operating room temperature.

02 FLIR data were analyzed to identify the areas of highest temperature readings surrounding the preoperative surgical markings to compare the patient's adjacent normal skin and adjacent affected areas.

03 The goal was to evaluate the accuracy in resecting affected skin while preserving healthy skin- no changes to surgical markings were made based on FLIR analysis.

04 Patients were monitored for up to 6 weeks during their post-operative visits to assess for missed areas of disease- indicated by persistent flares, adjustments to medications, and complications.

Table 1: Patient Demographics and Medical History

Patient	Age/Gender	BMI (kg/m^2)	HS Staging & Treatment
Patient 1	61-year-old female	42.84	• Hurley Stage III HS • Formerly on adalimumab (Humira)- not resumed in the post-operative period. • PMH: Obesity, hypertension, cardiomyopathy with atrial fibrillation, anemia
Patient 2	44-year-old female	45.19	• Hurley Stage III HS • Secukinumab (Cosentyx) 150 mg/mL subcutaneously BID- resumed postoperatively. • PMH: Obesity, hypertension, hyperlipidemia, obstructive sleep apnea, tobacco use


FIGURE 1

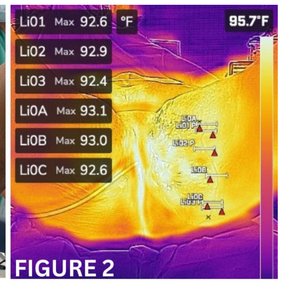

FIGURE 2

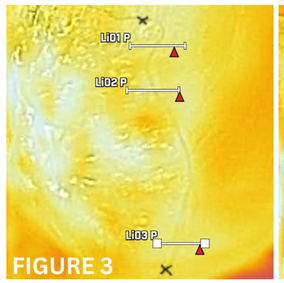

FIGURE 3

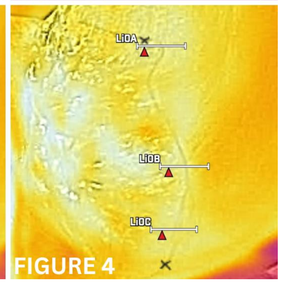

FIGURE 4


FIGURE 5

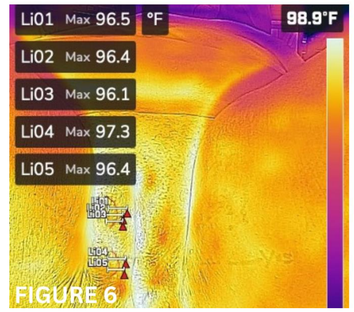

FIGURE 6

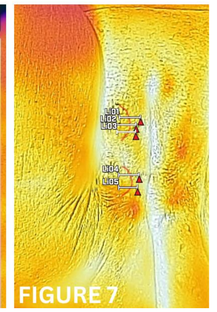
FIGURE 7

Figure 1: Patient 1- Preoperative markings on left medial thigh (35 cm x 30 cm).
Figure 2: FLIR thermal imaging of Patient 1. Li01P, Li02P, and Li03P indicate regions where the maximum temperature readings (red triangles) extend beyond the borders of the preoperative markings. Li0A, Li0B, and Li0C denote regions where the maximum temperature readings (red triangles) fall within the borders of the preoperative markings. The start and end points of the temperature analysis are marked with "x".
Figure 3: FLIR thermal image of Patient 1. Temperature analysis highlights the maximum temperature reading (red triangle) in relation to the surrounding skin **outside** the borders of the preoperative markings (lines Li01P, Li02P, and Li03P).
Figure 4: FLIR thermal image of Patient 1.Temperature analysis highlights the maximum temperature reading (red triangle) in relation to the surrounding skin **within** the borders of the preoperative markings (lines Li0A, Li0B, Li0C)
Figure 5: Preoperative markings on the right labia of Patient 2- Anterior vulvar (4 cm x 2 cm) and posterior labial lesion (3.5 cm x 2 cm).
Figures 6 and 7: FLIR thermal imaging of Patient 2. Medial surgical border markings indicated by the red line for both lesions on the right labia. Lines labeled Li01, Li02, Li03, Li04, and Li05 represent the locations of maximum temperature readings (red triangles) relative to adjacent skin, observed outside the borders of the surgical markings..

Results

PATIENT 1: 61-year-old female referred to plastic surgery for HS involving the left thigh and inguinal region (**Table 1**)- this study focuses on the resection of her left inner thigh (**Figure 1**).

Post-operative care:
- Inpatient management with subsequent transfer to an acute care facility for complex wound management.

Follow-up period:
- Mild wound edge dehiscence with seropurulent discharge and cellulitis.
- US findings revealed an abscess on the left inner thigh.
- Laboratory results showed an elevated white blood cell count and a decrease in hemoglobin levels (she remained hospitalized until her labs normalized).
- No new lesions, flares, or signs of infection observed around the surgical site.

PATIENT 2: 44-year-old female referred to plastic surgery for HS involving the bilateral vulva, left inguinal region, and left thigh (**Table 1**)- this study focuses on two HS lesions located on the right anterior vulvar and posterior labia (**Figure 5**).

Post-operatively care:
- Outpatient wound care clinic where she received routine debridement during clinic visits.

Follow-up period:
- Continued on pre-operative dose of secukinumab (Cosentyx)- managed by dermatologist.
- No signs of infection.
- Minimal drainage, no complications, and no new lesions or flares surrounding the two surgical areas.

Clinical Pearls

- **FLIR imaging can help identify subclinical disease beyond visible preoperative markings**: potentially guiding more precise resections and reducing disease recurrence
- **Environmental factors can impact FLIR accuracy**: making standardized conditions like those in the OR preferable for optimal accuracy

Discussion

For patient 1, wound dehiscence and potential for infection were anticipated complications.
- Extending the resection could have improved post-operative outcomes by removing additional diseased or infected tissue.
- Reducing the extent of resection could have minimized wound dehiscence.
- This assessment is complicated by confounding factors (lesion's location, pre-operative condition of the diseased skin, patient's comorbidities).

Patient 2 had an uncomplicated post-operative healing period.
- A longer follow-up period is required to determine whether subclinical areas of disease adjacent to surgical sites were missed and might lead to future disease recurrence.

The FLIR ONE is a cost-effective and accessible option for surgical planning in HS.
- The FLIR ONE device has limitations- environmental factors (lighting, airflow, humidity) can impact thermal readings [3].
- These limitations pose challenges in clinical settings but is less problematic in the operating room where standardized conditions are more achievable.
- Thermal cameras capture surface temperature by reflecting underlying inflammation [3].
- US and MRI may offer additional insights into deeper tissues.
- Our findings suggest that FLIR imaging could complement these methods by offering real-time feedback on resection margins and identifying areas of subclinical disease.

Conclusion

This pilot study highlights the potential role of FLIR imaging in enhancing surgical planning for patients with HS.
- The methods in this study provide a framework for future studies into the application of thermal mapping to optimize HS resections.
- A longer follow-up period is necessary to monitor disease recurrence and delayed complications.
- A larger sample size is needed to differentiate between post-operative complications related to surgical resection versus patient-specific factors.
- Direction for future studies:

1. Compare FLIR imaging with other imaging modalities in terms of sensitivity and specificity in detecting subclinical disease and optimizing surgical outcomes.
2. Investigate its role as an adjunct device for surgical planning.

References

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