INTRODUCTION

As part of a comprehensive strategy for limb preservation in high risk populations, remote temperature monitoring has emerged as an efficacious [1-3] and recommended [4-6] modality for detecting the inflammation that precedes diabetic foot ulcers (DFU). The approach most commonly studied involves daily measurement of temperature differences, or “asymmetry,” between six contralaterally-matched anatomical locations, or “keypoints” (Figure 1). Large persistent asymmetry can indicate tissue damage and inflammation, which can be addressed through preventative intervention such as offloading or treatment of pre- ulcerative lesions such as callus.

While the efficacy of thermometry is well established, better guidance on clinical interpretation of the foot temperature data may provide richer context to inform tailored interventions. Several authors [7-9] have used the angiosome model (Figure 1) for assessing temperature data at discrete times. We hypothesize that the concept of angiosomes may provide a framework for interpreting daily foot temperature data as well.

METHODS

In a multi-center trial [10], 129 participants with history of DFU were followed with a remote temperature monitoring mat for 34 weeks. The details of all DFU occurring during participation, including anatomical location and dates of presentation and epithelialization, were collected. In addition, the mat collected daily high-resolution temperature maps, or “thermograms,” of the plantar surfaces of the feet for periods during which participants were ulcer-free.

DFUs were grouped according to their closest temperature asymmetry keypoint, with the exception of wounds to lesser digits, which were grouped separately, and an aggregate of all thermograms in the two months preceding a DFU was compiled (Table 1). To assess patterns and spatial correlation of inflammation preceding DFU, the 75th percentile asymmetry during these two month periods were stratified by location and correlated via plantar angiosomes.

TABLE 1 DFU Location & Thermogram Summary

<table>
<thead>
<tr>
<th>DFU Location</th>
<th>Number of DFUs</th>
<th>Number of Patients</th>
<th>Thermograms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heal</td>
<td>3</td>
<td>3</td>
<td>69</td>
</tr>
<tr>
<td>Sub 5th Metatarsal</td>
<td>6</td>
<td>6</td>
<td>205</td>
</tr>
<tr>
<td>Sub 3rd Metatarsal</td>
<td>8</td>
<td>5</td>
<td>156</td>
</tr>
<tr>
<td>Sub 1st Metatarsal</td>
<td>14</td>
<td>13</td>
<td>546</td>
</tr>
<tr>
<td>Hallux</td>
<td>13</td>
<td>13</td>
<td>458</td>
</tr>
<tr>
<td>Lesser Digits</td>
<td>9</td>
<td>7</td>
<td>347</td>
</tr>
<tr>
<td>Arch</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

CASE EXAMPLE 1

65 year old male with T2DM (HbA1c = 7.9%), history of right foot Charcot arthropathy, rocker bottom deformity, and right midfoot ulcer

- Prior DFU healed on day of enrollment
- Inflammation detected at end of week 1 throughout medial plantar artery (MPA) angiosome
- Inflammation persists for three weeks
- At beginning of week 4 patient presents with right sub metatarsal 1 DFU (UT1A)

![Figure 1 Asymmetry Keypoints & Angiosomes](image)

RESULTS

A total of 53 DFU to 37 participants were observed, and a total of 1,781 thermograms were collected during the two months preceding these wounds. Aggregate data on the 75th percentile temperature asymmetry of these thermograms stratified by DFU location are presented (Figure 2). Despite being thermally-isolated, the 1st metatarsal head and hallux temperatures are highly correlated (MPA) for wounds to these locations, suggesting shared vascularity, whereas despite being a similar distance apart anatomically and less thermally-isolated, the asymmetry at the 1st metatarsal head (MPA + LPA) and 3rd metatarsal head (LPA) are less correlated (Case 1 & Figure 2(a-b)). Inflammation to the heel, supplied by the MCA and LCA, appears isolated from the forefoot, supplied by the MPA and LPA (Case 2 & Figure 2(c-e)). DFU occurring at the 5th metatarsal head show involvement extending into arch and 3rd metatarsal (LPA) (Case 3, Figure 2(d)).

![Figure 2 Asymmetry Preceding DFU](image)

CONCLUSION

These data suggest the angiosome model may provide a helpful framework for interpreting daily remote temperature data, potentially enabling tailored interventions and reduction of incidence. Additional investigation is warranted.

REFERENCES


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