Tracking digital ulcers in systemic sclerosis: Feasibility study assessing lesion area from patient-recorded smartphone photographs

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Introduction

- Approximately 50% of patients with systemic sclerosis (SSc) will develop painful digital (finger) ulcers (DUs) at some point during their disease course (See Figure 1 for examples).
- DUs can be extremely disabling and are often difficult to treat, requiring close monitoring of healing progression. Also, DUs are often the primary outcome measure in clinical trials of SSc-related digital vasculopathy.
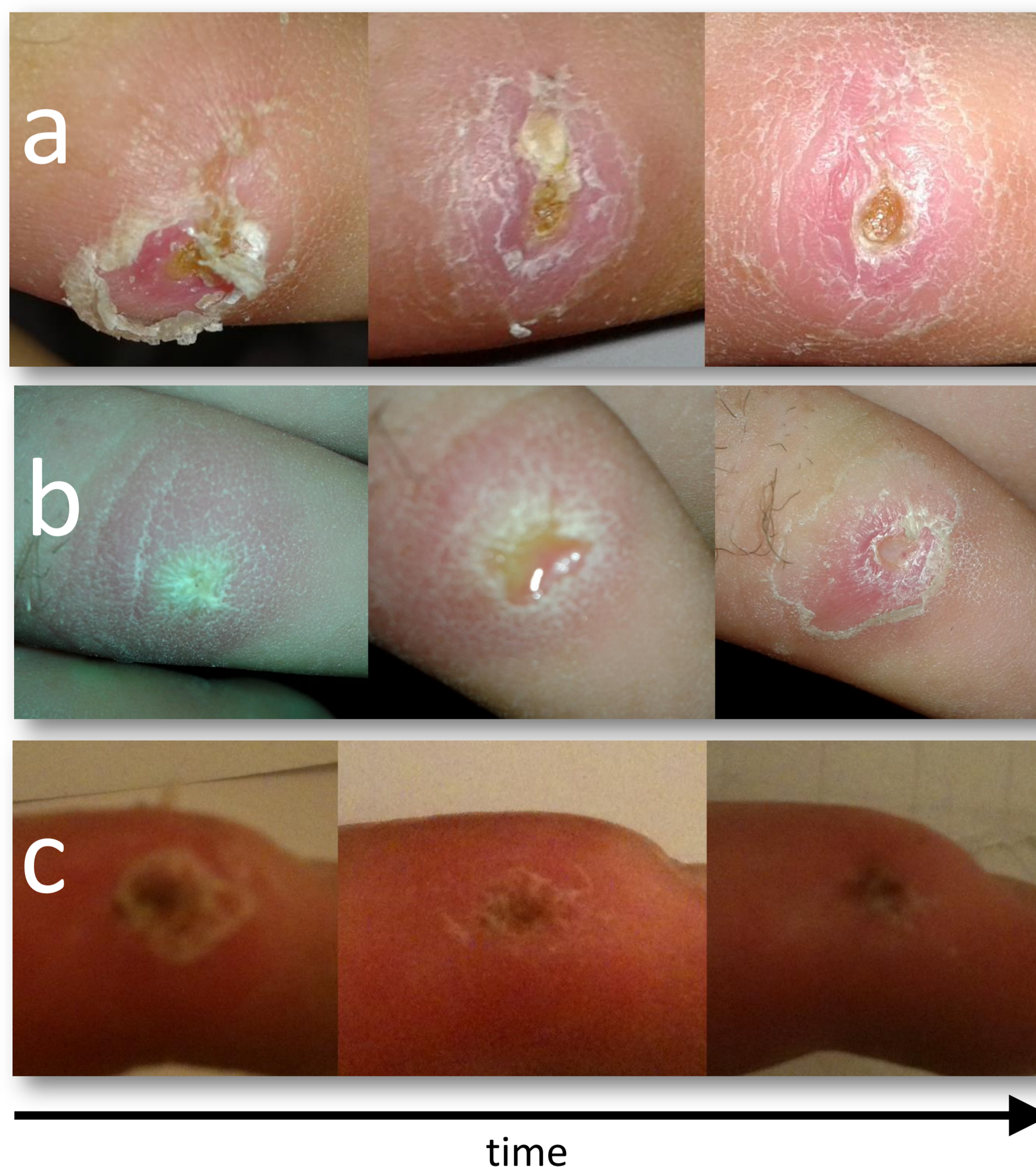

Figure 1. Three time sequence DU photographs (a, b and c). Photographs taken by patients using their own smartphone camera. Sequences as shown cover 30, 12 and 18 days, respectively. (Sequences a, b and c are lesions 4 ,5 and 6 respectively in Figure 3).

Objectives

- To demonstrate the feasibility of patients with SSc taking smartphone photographs of their DUs;
- To use software image analysis on collected images to track lesion area as a marker of wound status.

Method

Patients
- Four patients with SSc and incident DUs were asked to photograph their lesion(s), using their own smartphone, once per day for a maximum period of 35 days.
- Patients received normal clinical wound care for the duration of the study, which in most cases was patient self-management.
- Images were collected from the patients at the end of the study period.

Image Analysis
- Image length scales were initially calibrated using a fixed (non-varying) object in each image sequence, allowing relative length/area tracking throughout a sequence.
- Using digital planimetry software (developed and successfully tested in previous work on digital ulcer photographs [1]), lesion area was measured by fitting an elliptical shape to the wound image by a single observer (See Figure 2).
- Areas from each image were then normalised to the area measured first in the time sequence.
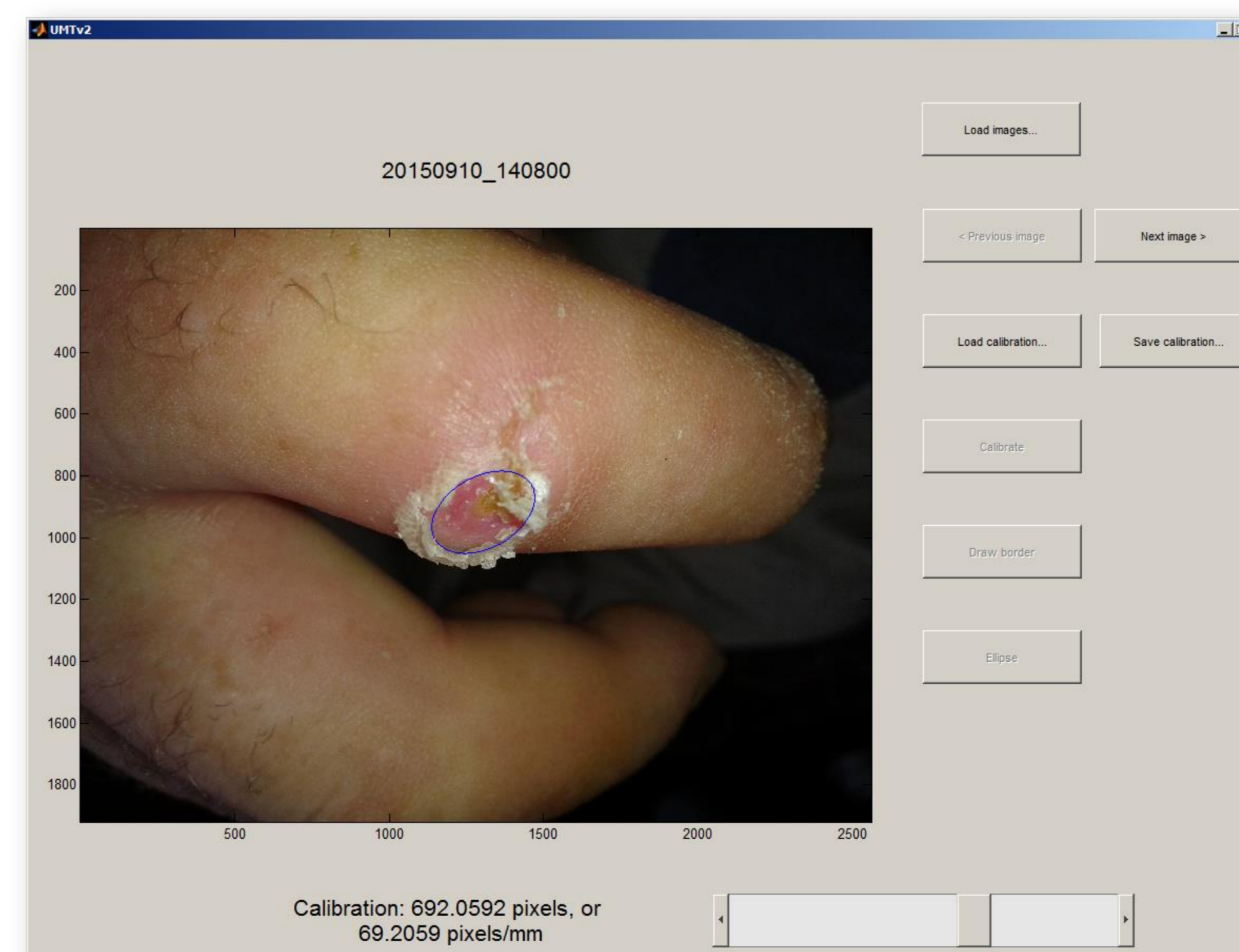

Figure 2. Digital planimetry software interface, showing ellipse-fitting step to a digital ulcer image. The ellipse (blue) is initially defined by two end-points, then the slider (bottom) is used to adjust the width until the ellipse best fits over the ulcer.

Results

- Image sequences describing 7 lesions were collected in-person at the end of the study period from the 4 patients (examples in Figure 1).
- The 7 image sequences cover a median [range] period of 29 [13-35] days.
- The relative area time course for each lesion is shown in Figure 3. At sequence end, relative lesion areas had, on average, reduced to 56% of the area measured on day 1, with 6 out of 7 lesions reducing in size over the study period.
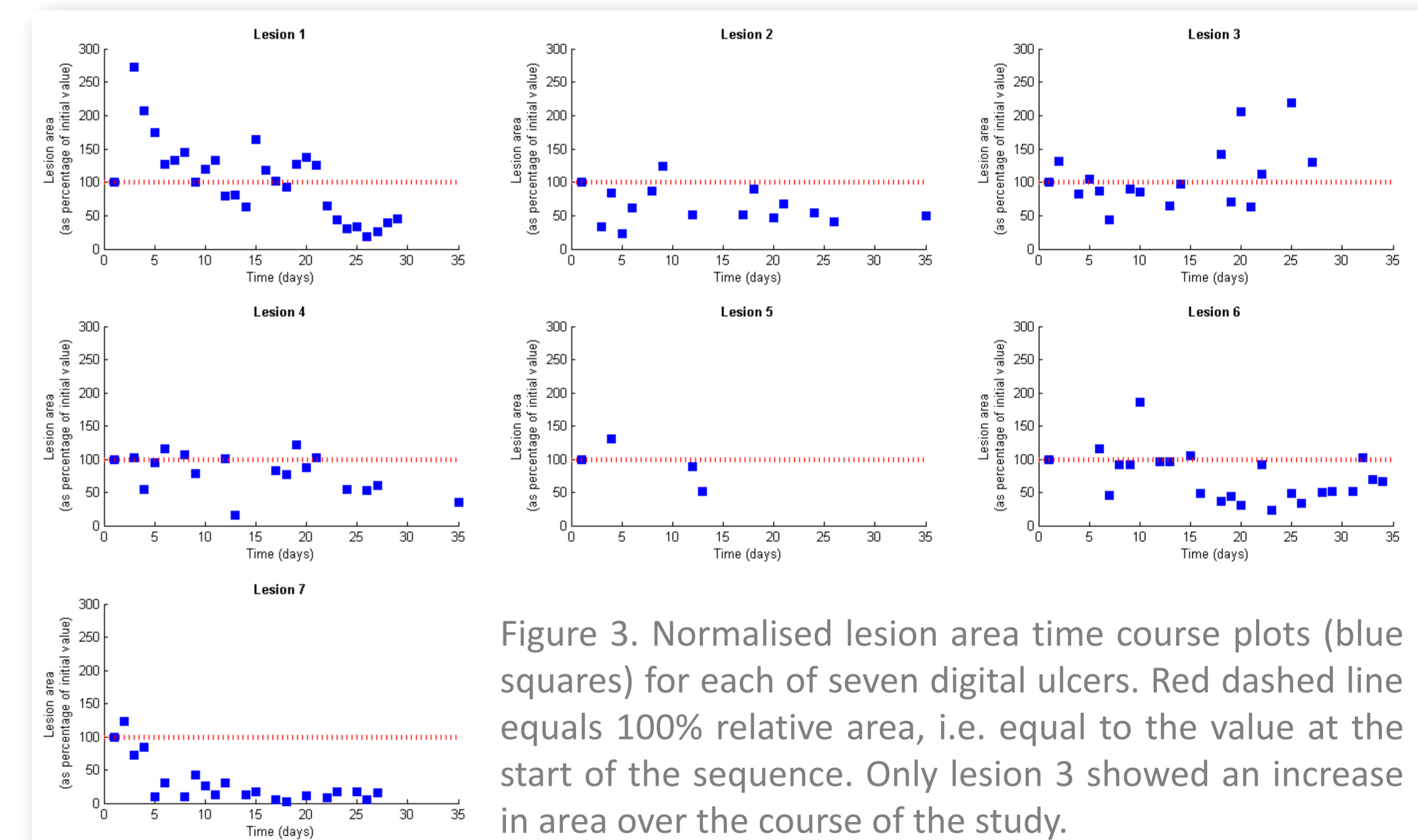

Figure 3. Normalised lesion area time course plots (blue squares) for each of seven digital ulcers. Red dashed line equals 100% relative area, i.e. equal to the value at the start of the sequence. Only lesion 3 showed an increase in area over the course of the study.

Conclusion

- We have demonstrated the feasibility of patients with SSc collecting images of digital ulcers using smartphone cameras.
- Images collected are of sufficient quality to allow software monitoring of wound progression (healing or worsening).
- Further work to build a smartphone app for lesion monitoring (for use in both clinical practice and as an outcome measure in clinical trials) is now required.

[1] Simpson et al. Arthritis Care & Research, 2017, doi:10.1002/acr.23300

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