Tracking digital ulcers in systemic sclerosis – a feasibility study assessing lesion area in patient-recorded smartphone photographs

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Key message: Patient-recorded photographs of digital ulcers are feasible, and photographic measurements may help monitor healing.

Author contribution statement:

GD responsible for study design, data collection, data analysis, and editing and approval of manuscript.

TM, JM responsible for data collection, and editing and approval of manuscript.

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Competing interests:

All authors declare no conflicts of interest.

Sir,

Systemic sclerosis (SSc)-related digital ulcers (DU) are painful, and disabling[1-3], and digital ulcer burden is often the primary outcome measure in clinical trials of SSc-related digital vasculopathy[4]. This is despite several studies showing a lack of agreement between rheumatologists as to what constitutes a DU[5-8].

Objective outcome measures of SSc-related DUs for tracking change over time are therefore urgently required for clinical practice and research studies. The application of digital planimetry to clinical DU photographs has shown the possibility of fine-grained measurement of DU characteristics (area)[9]. Our aims were to: (1) demonstrate the feasibility of patients with SSc-related DUs/digital lesions photographing their lesions using smartphone cameras, and (2) use digital planimetry-style software analysis on images collected from patients to measure and track lesion area as a marker of healing or progression.

Patients with SSc-related digital lesions (judged to be ulcers by an experienced clinician) were asked to photograph their lesion(s) daily, using their own smartphone, for a maximum of 35 days. All patients gave written, informed consent. All patients were taking vasodilators, and 1 was on immunosuppressant therapy (methotrexate). The patients received normal clinical wound care throughout the study period, after which images were collected in-person, and stored securely for further analysis (see Figure 1 for examples).

Time and date stamps were extracted for each patient image sequence to accurately describe chronology. Images were loaded into custom digital planimetry software[9] and initially calibrated using a fixed-size object (often the finger width) to allow comparison between images in the sequence. For each image, the lesion area was measured by fitting an elliptical shape to the outline of the lesion by a single observer (Figure 1). Using the calibration information, areas from each image were finally normalised to the area measured in the first image in the sequence.

Image sequences were collected from four patients describing a total of seven lesions (one patient with three lesions, one patient with two lesions, two patients with one lesion). The median (range) sequence duration was 29 (13-35) days, and for number of images recorded/day 0.63 (0.31-1.00). The relative area time course for each lesion is shown in Figure 2. On average, lesion areas had, by study's end, reduced to 56% of the area measured on day 1, with six out of seven lesions reducing in size over the time course.

This pilot study confirms that it is feasible for patients to monitor their own lesions over an extended period (weeks) by taking photographs with their smartphone camera. Photographs were taken on approximately 2 out of every 3 days during the study period, suggesting patients were highly engaged in the process. Collected photographs were of analysable quality.

This study therefore suggests a potential new tool for monitoring of lesion status/healing, both in the clinical setting, and as an outcome measure in clinical trials of SSc-related digital vasculopathy. Further work involving larger numbers of patients is now required to validate measurements produced, and to improve data collection by integrating imaging into a smartphone application.

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References

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Figure legends

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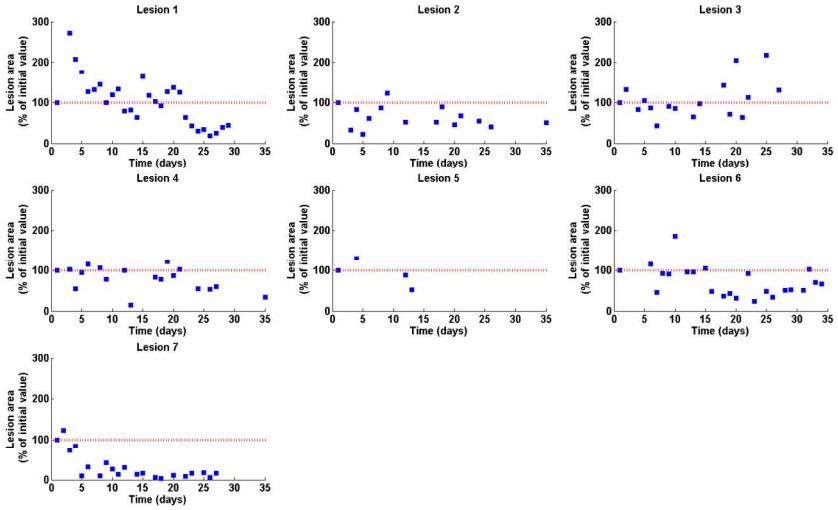

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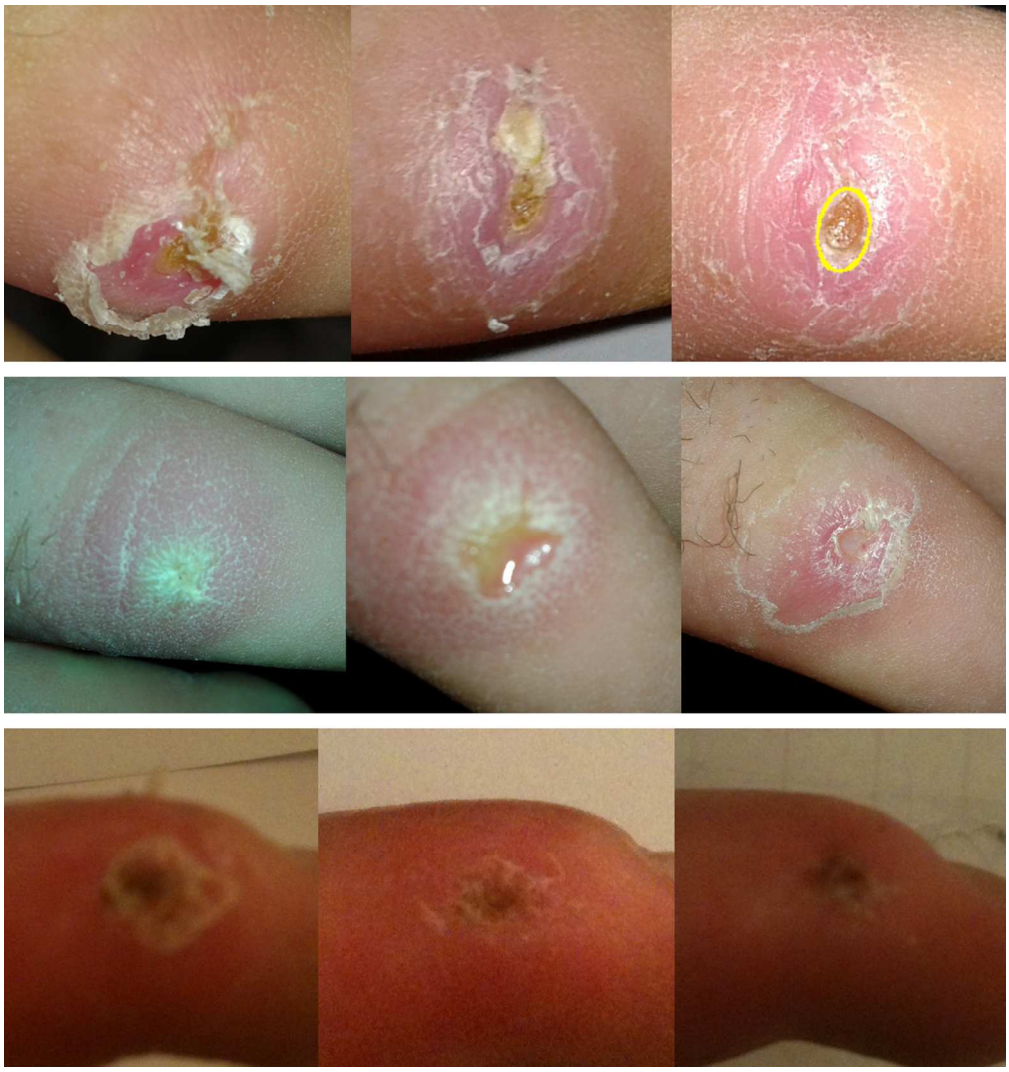
162x91mm (300 x 300 DPI)



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113x120mm (300 x 300 DPI)

Professor Josef S Smolen,

Editor, Annals of the Rheumatic Diseases

15th January 2018

Dear Professor Smolen,

Manuscript: **annrheumdis-2017-212829**

Title: **Tracking digital ulcers in systemic sclerosis – a feasibility study assessing lesion area in patient-recorded smartphone photographs**

Thank you for your email of 5th January 2018. We are pleased at the interest in our manuscript and appreciate the reviewers' comments. Our response is detailed below:

Comments to Author:

Reviewer: 1

Comments to the Author

the present letter has the aim to report on the feasibility of SSc patients with DU to photograph their lesions with a smartphone camera, and on the possibility to use digital planimetry-style software to analyse the collected images.

major problems:

1: the number of DU is really low to draw any conclusion. The authors shoudl add some more case with different kind of ulcers

2.the pictures of DU from 3 different cases are unclear. Are these ulcers ? I see scabs and healing how do the authors define an ulcer. I have difficulties in seeing the bottom of the ulcer.

3.did the authors classify DU before asking the patient to take pictures ?

4.were patients on treatment, immunesuppresant and/or vasodilating ?

the authors ought to work on details and provide a substantially strenghtened version of the paper.

Authors' response

1: We appreciate that only a small number of digital lesions are included in our analysis. However, we would stress the pilot nature of our study and that the primary objective of this work was to assess the feasibility of (1) patients capturing their own images, and (2) captured images being of sufficient quality that they can be further analysed as described. We think that, despite the small numbers of lesions included, we have sufficiently demonstrated both aspects of this feasibility to encourage further work in larger studies (now emphasised in the last sentence).

2: We are acutely aware of the difficulties of defining digital ulcers. For the purposes of this work we included lesions that had been classed as a digital ulcer (DU) by the treating physician for clinical/treatment purposes (this point has now been added in the revised manuscript) , but did not specify any further restrictive criteria such as depth or specific characteristics. We are primarily interested in monitoring healing using our described methods – a lesion, regardless of its status as a DU, will still need to be carefully monitored for healing/progression. In order to remove potential for confusion we have altered a number of references to “digital ulcers” or “DUs” to refer instead to “digital lesions” or “lesions”. These changes are marked on the revised manuscript.

3: As above (point 2), ulcers/lesions were included following diagnosis by the treating physician. No further classification was applied to the lesions, once included.

4: We have added details of the treatments (immunosuppressants and vasodilators) that the patients were taking to the manuscript.

Reviewer: 2

Comments to the Author

The authors developed a new patient-reported smartphone photograph technic and analysis to follow the healing/worsening of digital ulcers in systemic sclerosis. The basic of a special digital planimetry technic for quantifying digital ulcers in systemic sclerosis has already published recently (Reference 9).

This work demonstrated the feasibility of a self-management patient photographing method to follow their lesions using smartphone cameras. The digital planimetry-style software used in it proved to be adequate. Correct and accurate method and demonstration.

After testing on a larger patient number it can be a pontential new tool both in the daily practice and for clinical trials also.

Excellent methodological work but it does not fit into the original concept of the ARD.

Authors’ response

As Reviewer 2 states, we have previously published our work on digital planimetry as applied to photographs of digital ulcers in systemic sclerosis (reference 9 in the manuscript). However, the work in the current manuscript is concerned with 2 novel aspects: (1) the feasibility of patients

capturing images themselves using a smartphone camera (the photographs in the previous study were taken by a medical photographer in the hospital), and (2) whether images taken by the patients (with all the potential quality control issues that may occur) were then able to be measured using digital planimetry techniques.

We agree with the reviewer that further work in a larger study is now required and (as mentioned in response to Reviewer 1) have added in our last sentence '…involving larger numbers of patients'.

We would contend the point that this work does not fit into the original concept of ARD. Indeed, in the "Instructions to authors" section on the ARD website the first sentence describing the "Letter" format for manuscripts states: "Short clinical or laboratory observations (eg preliminary or confirmatory data) may be presented as a Letter to the Editor". We would suggest that that this manuscript is both "preliminary" (early stage/pilot work) and "confirmatory" (applies an analysis method to a new data set).

We have made a small number of other changes (all tracked) to keep within the word count.

We hope that our responses have addressed the reviewers' comments satisfactorily, and we look forward to hearing from you.

Yours Sincerely,

Graham Dinsdale (on behalf of all authors)