Smart Imaging and Deep Learning for Objective Psoriasis Lesion Scoring: A Scarletred AI Proof-of-Concept Study

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Introduction

The assessment of psoriasis severity requires detailed and robust lesion segmentation and tissue classification. This proof-of-concept study aimed to automate the classification of psoriasis disease severity on skin lesions using sophisticated deep-learning algorithms. Despite remarkable progress in computer-aided diagnostics, there remains a scarcity of effective methodologies for analyzing and categorizing psoriasis. In this study, which was part of a randomized, controlled trial in psoriasis patients (NCT04394936), we proposed a robust pipeline to collect a dedicated, diverse and curated dataset.

Results

Our study findings reveal that the proposed model achieves high precision and accuracy across various tasks. This includes lesion segmentation, yielding a dice coefficient of 0.85, whereas for tissue classification, our model achieves a test accuracy and an F-score of 97%. Furthermore, our model estimates lesion severity for erythema, scaling and induration, attaining scoring correlations of 65%, 72% and 83%, respectively, between experts and AI, by implementing a four-class prediction framework that covers grades 0, 1, 2, and 3.

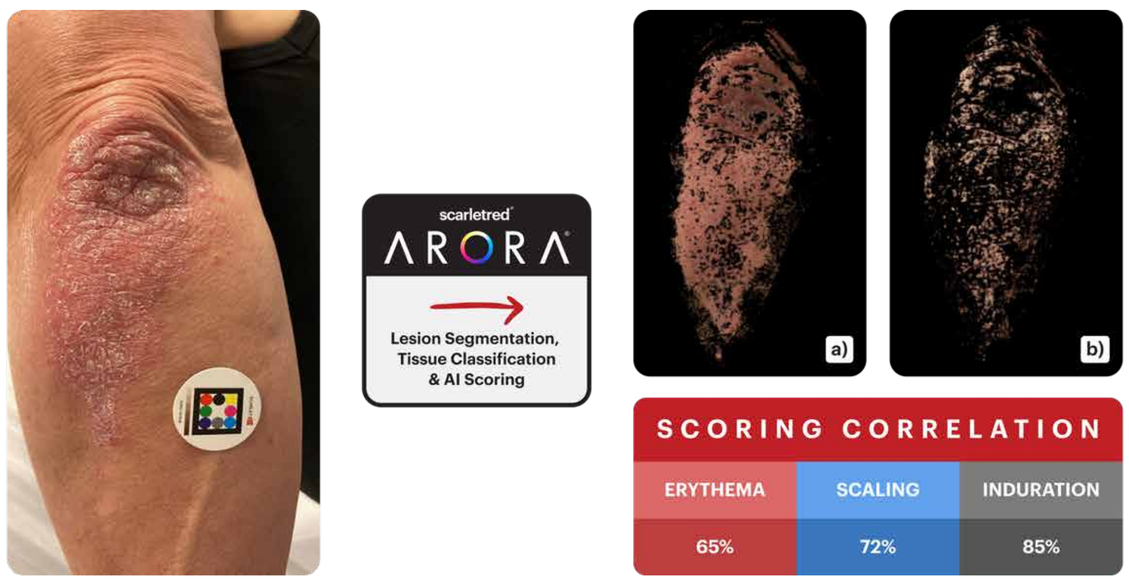

Figure 1: AI tissue classification of erythema (a) and scaling (b) regions on exemplary psoriasis lesion, with overall evaluation of correlation between AI and expert scores for the assessed parameters.

When considering full body images, our approach involves automatic body segmentation for a better approximation of the clinical practice. This process not only facilitates the extraction of the lesions for AI-based classification and scoring but also enables lesion localisation and estimation of affected body surface area.

Notably, we demonstrated that successful AI assessment has been attained using a significantly reduced input dataset compared to prior undertakings in this domain, showcasing a noteworthy advancement in efficiency and its use for prospective rapid AI prototyping in clinical and hybrid trial environments, with the objective of enhancing expert decision-making.

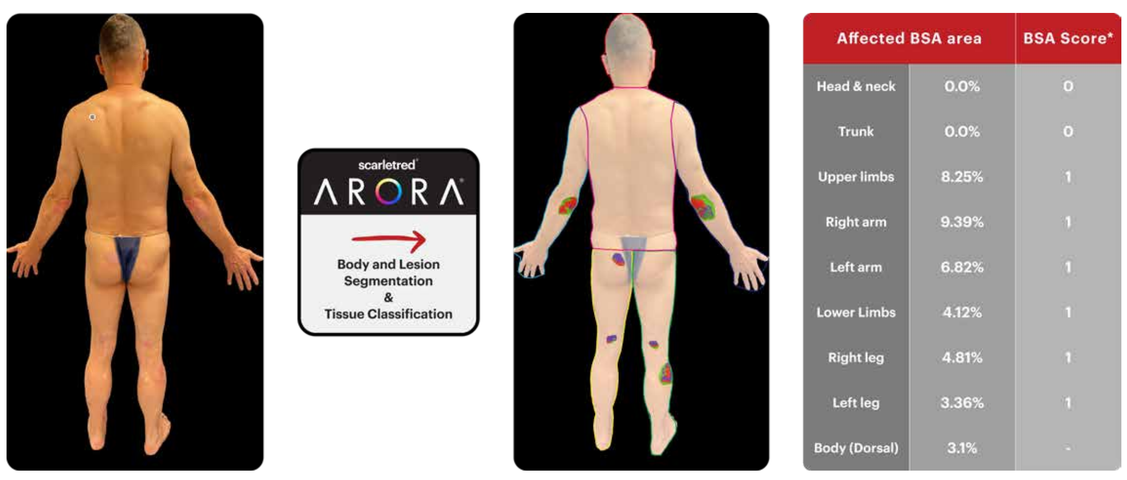

Figure 2: AI body segmentation on whole-body image of the patient, with lesion segmentation and body surface area calculation on the right (* BSA: 1-9% (score 1), 10-29% (score 2), 30-49% (score 3), 50-69% (score 4), 70-89% (score 5) or 90-100% (score 6))

Intended use of the Scarletred® Vision system

Scarletred® Vision is a clinically validated and approved Software as a Medical Device (SaMD) platform for contactless monitoring and objective digital assessment of cutaneous drug effects, skin conditions, or changes in skin pigmentation. The Scarletred® Mobile App integrates the use of the Scarletred® Skin Patch, which serves as an internal reference and enables to standardize and automate the process of image documentation and measurement. The patented system is supplied online and used worldwide in pre-clinical and clinical phase I-IV studies in a broad range of indications and product biocompatibility testing.

Materials and Methods

From 26 patients, we used a total of 152 images of representative psoriasis target plaques and 206 images of body regions affected by psoriasis, both acquired with Scarletred® Vision operating through an iOS-App on smartphones. To enhance our dataset, we applied data augmentation techniques and transformed the images into the SEV* and CIE-Lab* signal maps, effectively broadening the spectral diversity for deep learning model training. Our methodology involved implementing a lesion segmentation using a deep learning algorithm which was followed by a tissue classification model to identify erythema, induration and scaling features within the segmented lesions. Lastly, we assigned expert severity scores to each image, facilitating the estimation of the overall severity grade of the skin disease. This algorithm seamlessly integrates into the platform's proprietary image augmentation pipeline.

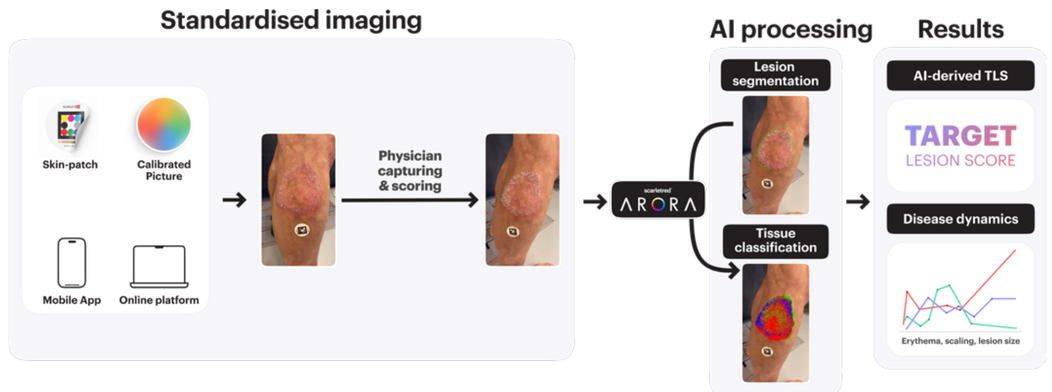

Figure 3: Workflow for AI-based psoriasis lesion assessment using standardized smartphone images

Monitoring Disease Dynamics

The utilization of lesion detection and tissue classification algorithms allows an advancement in the assessment of psoriasis lesions during the treatment. These algorithms offer fast and objective tracking of the changes in lesion composition and distribution, enabling clinicians to gauge the efficacy of therapeutic interventions accurately. This will not only enhance patient care by ensuring timely adjustments to treatment plans but also facilitate a more personalized approach in managing psoriasis, ultimately improving treatment outcomes and patient satisfaction.

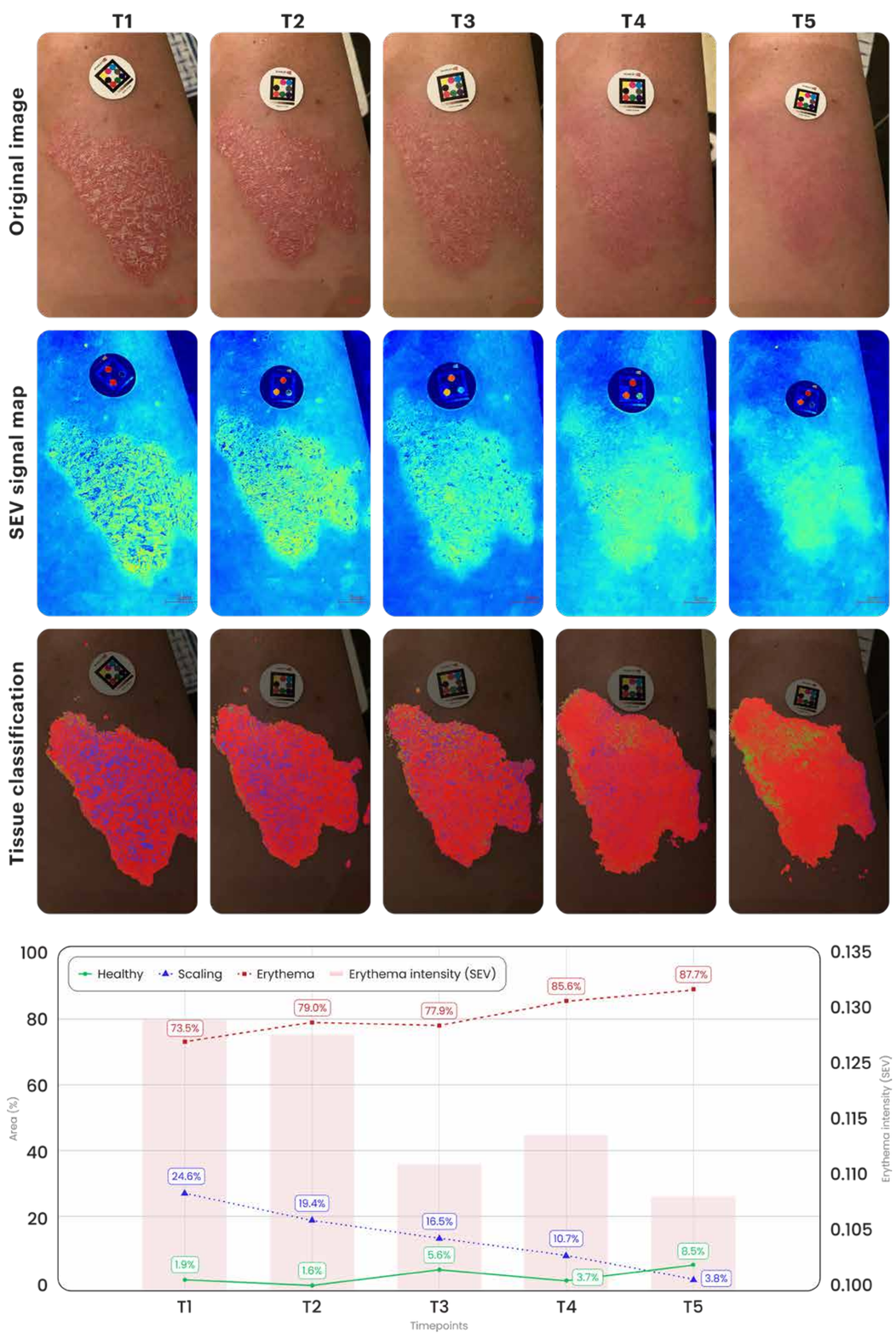

Figure 4: Sequential assessment of a local psoriasis lesion throughout the treatment process, including analysis of lesion composition and measurement of erythema intensity using the Standard Erythema Value (SEV)

References
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