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WHAT'S NEW

«Rethinking Skin Stiffness Assessment: The Journey from Subjectivity to Objectivity»

This section is a contribution from the SKINTEGRITY.CH interdisciplinary research consortium. Dr. Thumm and Dr. Sachs, who lead the ETH spin-off CITUS AG and write about it here, were both part of the SKINTEGRITY.CH Young Investigator Program and the spin-off has its roots in several of the consortium's research groups.

Maarten Schledorn
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David Sachs, Bettina Thumm. *Skin stiffness assessment is vital in dermatological conditions, yet subjective methods like the modified Rodnan skin score (mRSS – clinical gold standard for skin assessment in systemic sclerosis patients) suffer from limitations. Here we introduce the NIMBLE, a device which offers an objective approach to measure skin stiffness. Clinical trials have demonstrated its efficacy in systemic sclerosis and scar assessment. The ETH spin-off CITUS AG aims to establish NIMBLE as a medical device, paving the way for improved skin healthcare.*

Introduction

The evaluation of skin stiffness plays a crucial role in the management of various dermatological conditions, such as systemic sclerosis, burn scars, lymphedema, and radiation therapy. However, the existing methods are prone to errors. In systemic sclerosis for example, the modified Rodnan skin score (mRSS) is used. The doctor pinches the skin at 17 different locations on the body, giving each location a score from 0 (healthy) to 3 (severe fibrosis). The quality of the assessment thereby strongly depends on the experience of the doctor. In scar assessment the Patient and Observer Scar Assessment Score (POSAS) is used, again relying on subjective measures to quantify the formation process of scars. In response to this challenge, the NIMBLE offers an innovative and objective approach to assessing skin stiffness. This article explores the development, validation, and future prospects of the NIMBLE in dermatological practice.

Objective Skin Stiffness Assessment with the NIMBLE

The NIMBLE [1], shown in *Figure 1(a),* represents a groundbreaking advance in skin stiffness assessment. It consists of a measurement station (white), a handheld (blue) and a disposable (grey). This state-of-the-art device utilizes a unique method to quantify skin stiffness. A measurement probe, shown in *Figure 1(b)* is gently placed on the skin, creating a cavity beneath. The subsequent removal of air from this cavity elevates the skin, see *Figure 1(c),* and the pressure required for this process becomes a precise indicator of skin stiffness. This objective methodology eliminates the subjectivity inherent in traditional assessment techniques.

Clinical Trials and Validation

A research collaboration between the group of Prof. Mazza of the mechanical engineering department of ETH Zürich and the group of Prof. Distler at the Department of Rheumatology at University Hospital Zürich led to the development of the NIMBLE. Clinical trials were conducted to evaluate its effectiveness. In a study involving 60 participants, including systemic sclerosis patients and healthy controls, NIM-

Figure 1: (a) The new NIMBLE consists of a measurement station (white), a handheld (blue) and a disposable (grey). (b) For a measurement the probe is placed on the skin and a vacuum is created, (c) the vacuum elevates the skin until a predefined height h is reached. The pressure required is a precise indicator of skin stiffness.

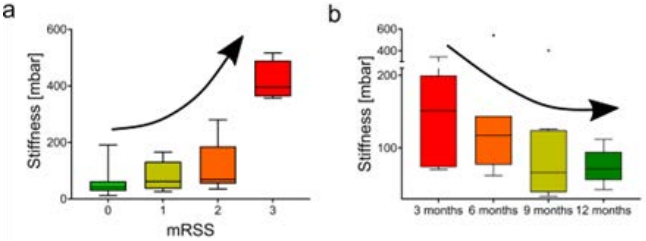

Figure 2: (a) In systemic sclerosis skin fibrosis leads to stiffening of the tissue. The NIMBLE quantifies the increase in stiffness from 25 mbar for healthy skin to over 400 mbar for severe fibrotic skin. (b) During treatments of scars softening effects of the skin are observed indicating if the treatment is successful. The NIMBLE successfully quantified the changes showing it's capability to longitudinally quantify changes.

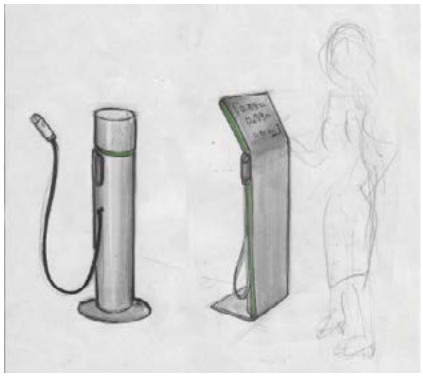

Figure 3: Motivated by the past success, the team works on new ideas for the next generation of the skin assessment device.

BLE's performance was compared with the mRSS and the Cutometer® (Courage & Khazaka GmbH, Germany). Results demonstrated NIMBLE's ability to detect differences in skin stiffness between groups [2]. As shown in *Figure 2(a)*, fibrosis leads to a skin stiffening. As fibrosis increases the stiffness of the skin increases, as measured by the NIMBLE from 25 mbar to about 400 mbar at the final stage. Furthermore, it outperformed the commercially available Cutometer®, achieving a r-value of the correlation with the mRSS of 0.82 compared to 0.58.

In a separate study, the NIMBLE was employed to assess scar tissue in 11 pediatric patients over one year [3]. Scars are initially stiffer than healthy tissue. Thus, during the scar formation process the stiffness of scars should reduce if successfully treated. The device proved to be sensitive in tracking changes in the softening of scares over the time period of one year as shown in *Figure 2(b)*. The stiffness reduces from about 150 mbar at the first measurement point, at 3 months after injury, to about 80 mbar at the final measurement point, at 12 months after injury. It thus proved to be a valuable tool for longitudinally assessing responses to treatments or interventions.

CITUS AG: Paving the Way Forward

The success of the NIMBLE led to the establishment of the ETH spin-off CITUS AG in February 2023 by the two experts in biomedical engineering, Dr. Bettina Thumm and Dr. David Sachs. This new company aims to secure the status of the NIMBLE as a medical device within clinical settings. The first product has completed development and is now available for research projects and clinical studies. Several studies are already planned across Europe. CITUS AG's future roadmap includes regulatory approval of the product as a medical device, to further enhance the mechanics of skin healthcare.

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