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Literature List
Nail StrainStress Meter

L.M. Rodrigues, J.W. Fluhr, **EEMCO Guidance for the in vivo Assessment of Biomechanical Properties of the Human Skin and Its Annexes: Revisiting Instrumentation and Test Modes**, Skin Pharmacol Physiol 2020;33: p. 44–59

Biomechanics of the skin is an important subject in skin research. It has been studied for many decades involving various technologies and methods to characterize and quantify mechanical properties of the skin under different in vivo conditions. The present EEMCO paper reviews the current relevant information, providing practical orientation to researchers dedicated to in vivo assessment of biomechanics of skin and its annexes. We discuss the available noninvasive instruments, including their principles and variables. A correspondence between the descriptors nomenclature proposed by Agache and the designation for the suction-based standard instruments is proposed. The addressed properties include skin softness/stiffness, firmness, elasticity, elastic and viscoelastic properties, extensibility, resilience, anisotropy, acoustical shock wave hardness, friction (in relation to topographic properties), thickness, fiber/stress-mechanics (bending, cyclic, tensile, fatigue, or torsion), and hardness. We provide the relation of these properties to biomechanical descriptors and in some cases to SI units. Practical guidance for the proper use of these instruments, limitations, and possible interpretations are provided, while discussing the meaning of descriptive or "phenomenological" variables. For studies intended to quantify the effect of an intervention with regard to mechanical properties, we recommend a minimum of 30–40 participants, based on normal distribution of the data sets. Some important limitations are recognized, including the lack of standardization of procedures and calibration of instruments, which compromises the relevance and real nature of the descriptors/parameters obtained with these devices. The present work highlights an approach to a better practice and a sciencesupported biomechanical assessment of human skin, hair, and nails.

P. Perugini, S. Sacchi, G. Musitelli, **Nail StrainStress Meter NM 100: A novel in vivo method to characterize biomechanical properties of nails**, Skin Res Technol., Volume 26, Issue 3, May 2020, p. 422-430

Background: Nowadays, nail care products are extremely important both in medical and cosmetic fields. Actually, there are only a very few "in vivo" methods to evaluate the safety and the efficacy of nail products. Methods: The new apparatus, based on a recently patented technology, is developed for the "in vivo" evaluation of nails in terms of thickness, structural firmness, flattening, and bending properties. The device analyzes nails by an "in vivo" non-invasive methodology in a timely way and with high accuracy. The assessment of the resistance to compression measures the cohesion of the nail matrix (nail firmness), while the evaluation of the resistance to transversal deformation detects the elasticity of the nail plate. Furthermore, the apparatus is able to assess the nail thickness and the flexibility of their distal edge. Results: The instrument provides nail thickness and several parameters reflecting mechanical properties of nail plate: Viscoelasticity expressed as viscoelasticity index (VI), structural strength/ firmness expressed as Firmness Index (FI), and viscoelasticity of the distal edge expressed as Bending Index (BI). Conclusions: The instruments described in this work represent an innovative apparatus for the safety and efficacy evaluation of nail products in several fields: cosmetics, pharmaceuticals, and medical devices.

D. Khazaka, C. Uhl, **Nails: more than just skin extensions,** PERSONAL CARE ASIA, May 2018, p. 33-35

The horn-like envelopes covering the tips of our fingers and toes are called nails. They are highly specialised epidermal appendages. Finger- and toenails are made out of a tough fibrous protein, the alphakeratine. The nail consists of the nail plate, the nail matrix and the nail bed below it, and the grooves surrounding it. Apart from the aesthetical aspect, a healthy fingernail has the function of protecting the fingertip and the surrounding skin from injuries and preventing the skin at the end of fingers and toes from rolling backwards over the distal phalanx. The nail helps to improve sensitivity and the grip of the fingers and also enables the precise manipulation of small objects through counter-pressure exerted on the pulp of the distal digits (e.g. pulling out a splinter in one's finger), as well as certain cutting or scraping actions.

P. Perugini, G. Musitelli, M. Bracchi, P. Capra, M. Bleve, **Nail StrainStress Meter NM 100: a novel, unique in-vivo method to characterize the biomechanical properties of the nail**, Poster at the 4th International Summit on Nail Diseases, June 2017, Athens

Aim of the work: Definition of the procedures to use the Nail StrainStress Meter NM100, a new apparatus based on a recently patented technology, for the “in vivo” evaluation of nails in terms of thickness, structural firmness, flattening and bending properties.

P. Perugini, G. Musitelli, M. Bleve, G. Khazaka, **Noninvasive measuring apparatus for the investigation of nail mechanical properties,** ISBS Lisbon 2016

The Nail StrainStress Meter NM100 is a new apparatus based on a recently patented technology (PCT/IB2014/067260), easy to use and developed for a quick and accurate evaluation of distal portion of nails in terms of thickness, compressive strength and deformation lengthwise and crosswise. Transversal deformation: The nail is deflected compressing the convex distal part. The slope of the curve indicates the elastic property of the distal nail plate. Longitudinal deformation: The nail distal edge is deflected leaving the end free to flex. The slope of the curve indicates the elasticity of the distal edge (border) of the nail. Resistance to compression force: The nail is compressed punctually. The slope of the curve indicates the structural strength of the nail. The distance before the nail is met and the curve starts indicates the thickness of the nail.

G. Musitelli, S. Sacchi, E. Raffaldi, P. Capra, P. Perugini, **Evaluation of safety and effectiveness of nail products by a versatile quantitative approach,** IFSCC 2014 Paris

Introduction: The nail plate, whose thickness is roughly in the range of 300–800 mm, is composed of three histological layers: the dorsal, intermediate and ventral plates. The nail plate is composed mainly of hard keratin and lipids, like hair. It was reported that the total lipid content in the nail plate was 1.4%, and that its fatty acid content was higher and ceramide content was lower than the stratum corneum.

G. Musitelli, S. Sacchi, M. Bleve, P. Capra, P. Perugini, **A new approach to evaluate in vivo biomechanical properties of nails,** ISBS Copenhagen 2012

Objective: Recently, a lot of new products claiming hardener, moisturizing or whitening effects about nails are developed. In according to requirements introduced by the 1223/2009 Regulation, it is mandatory to find and validate instrumental methods able to verify product effects. The aim of this work is to present a versatile quantitative approach in which measurements of thickness and water content are associated to a compression test for in vivo evaluation of flexibility and elasticity of the nails.