A high accuracy device for performing real stiffness measurement from stratum corneum to dermis, layer by layer in vivo :

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Introduction:

Human skin is particularly sensitive to ageing and undergoes profound structural and functional changes. These visible changes can affect our relations with others. Thus, developing effective products but also analytical equipments to guarantee their effectiveness is crucial.

During ageing, we observe a remodeling of the dermis with a decrease in the characteristics such as the quantity and structure of collagens, elastin, and other molecules, of the papillary compartment in favor of the reticular compartment accompanied by a flattening of the papillae. Organizational changes of the epidermis and a modification of the number of layers forming the SC are also shown. These structural changes irrevocably lead to biomechanical modifications of the tissue, resulting in sagging skin, loss of elasticity and wrinkling.

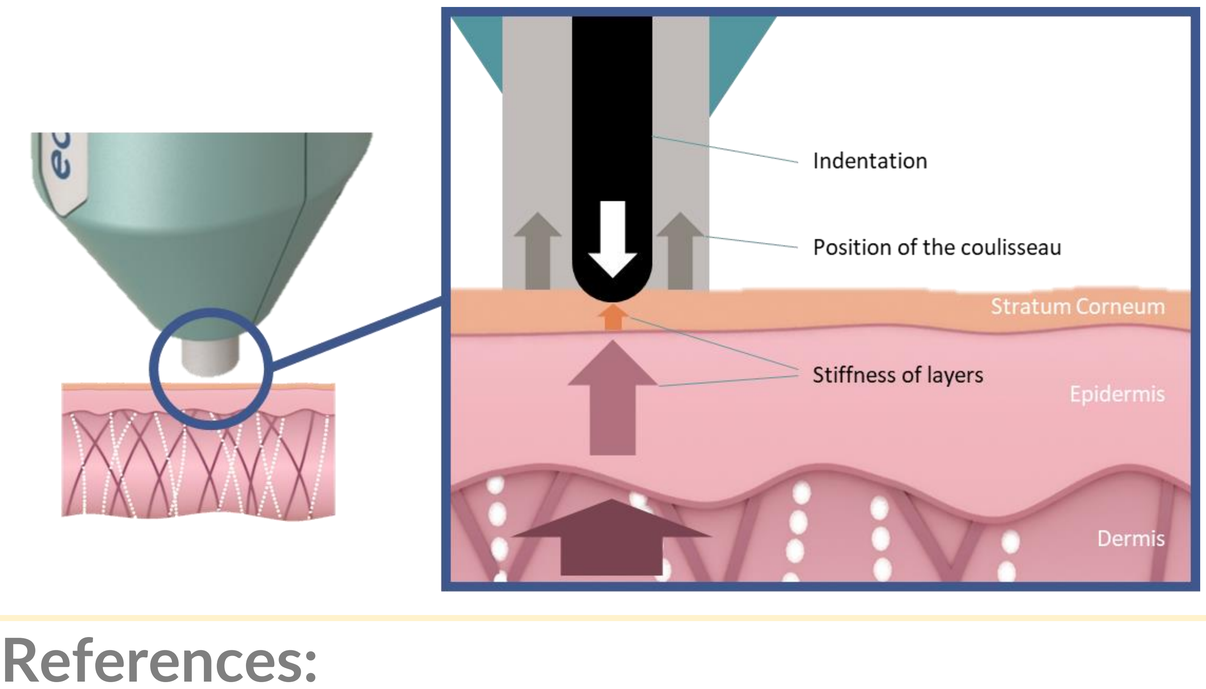
The data obtained with 3D in vitro skin models and ex-vivo skin models are not sufficient to understand the mechanisms involved in a whole organism. Thus, the biomechanical in-vivo study (i.e., on human volunteers) of the different compartments of the skin is an essential challenge to understand these mechanisms and eventually find the appropriate cosmetic formulas.

During a clinical study focused on ageing and the lower eyelid area, an area known to be very fragile, our own device was used to directly measure the stiffness of the different skin compartments. Based on a non-invasive surface deformation, the innovative measuring device EASYSTIFF® (BIOMECA, Lyon, France) is able to extract the true stiffness data from the different skin compartments: Stratum Corneum, epidermis, dermis and hypodermis.

Materials & Methods:

The measurements of EASYSTIFF® are based on indentation. The central indentation aperture was 5mm in diameter with a prob size of 2mm. One force/distance cycle was used, consisting in a displacement of the prob into the skin for 2s at 1.2 mm deep (max), followed by the release of the device. The data processing consisted in applying a mathematical model (Hertz model) based on the force/distance curves recorded. Each curve was processed, and the elastic modulus was extracted: global and tomography.

Our study involved 18 female volunteers aged between 21 and 34 years old. The aim of this study was to study the ageing of the eyelid skin. We carried out a comparative study of the different skin compartments according to age against the overall analysis of the skin.



Results & Discussion:

This study revealed a decrease in the stiffness of the SC, epidermis, and dermis. These results show an inter-compartment variability that is not distinguishable from the global analysis of the skin. Thus, EASYSTIFF® has allowed us to study the different skin compartments in a targeted way. This fine analysis allows us to observe the impact of age on the different skin compartments. To go further, we studied three types of lower eyelids: vascularized eyelids, pigmented eyelids and mixed eyelids. This compartmental analysis revealed an increase in the stiffness of the 3 skin compartments, SC, epidermis and dermis, for vascularized eyelids.

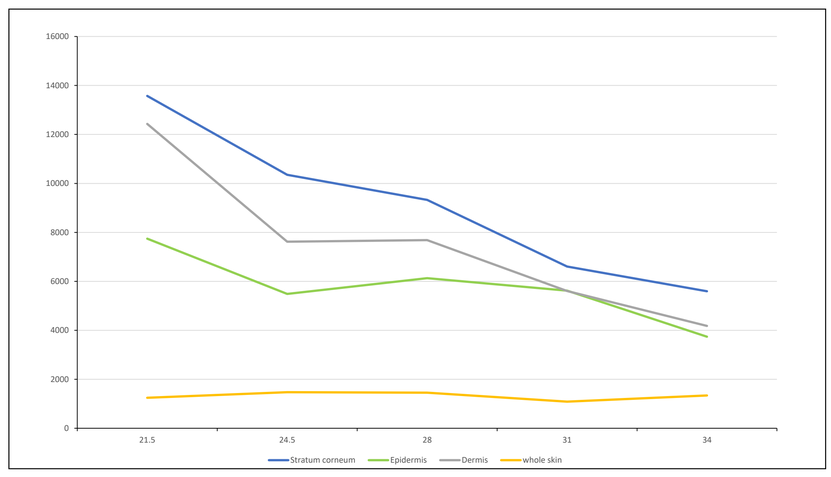


Figure 1: Graphical representation of skin stiffness by compartment and age with the EasyStiff measuring device

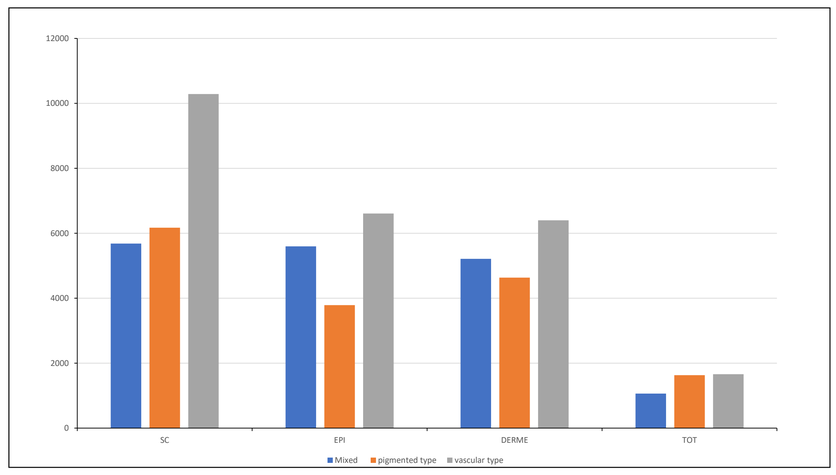


Figure 2: Graphical representation of skin stiffness by compartment and eyelids type with the EasyStiff measuring device

Conclusions:

EasyStiff is able to differentiate skin compartments through its tomography-based mechanical data extraction. It allows to perform fast non-invasive measurements on kinetic panelists. Its cross-platform web interface allows an easy use and management of the data to focus only on the results. Our study has shown a decrease of the mechanical parameters with aging on the different compartments while the global decrease of the skin varies very little. Moreover, we were able to highlight an increase in tissue rigidity on the different skin compartments of the vascularized eyelids allowing us to discriminate them.

Acknowledgements:

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References:

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