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MORPHO-MECHANICAL ANALYSIS OF RECONSTRUCTED SKIN UNDER TRACTION

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Summary: Introduction - Tissue engineered skin usually consist of a multi-layered visco-elastic material composed of a fibrillar matrix and cells. The complete mechanical characterization of these tissues, which would facilitate the development of skin equivalents that better mimic human skin, has not yet been accomplished. The purpose of this study was to develop a mechanical microscale approach to perform this characterization. As a proof-of-concept, tissue engineered skin samples were characterized at different stages of manufacturing.
Methods - This study was performed using reconstructed skin samples licensed by BASF Beauty Care Solutions, France. To evaluate the effect of sample structure on the mechanical properties, we mechanically characterized the acellular matrix (Mimedisc™), the reconstructed dermis and the reconstructed dermo-epidermis composite (Mimeskin™). Moreover, to understand the effect of aging, the entire process was performed using cells from donors of 18- and 61-year-old. Fives samples of each type were produced. Images of the internal network of the samples under stretching were acquired by combining confocal microscopy (A1R MP PlusTM, Nikon) with a tensile device (500N Compact MicrotestTM, DEBEN). Loading is performed at constant speed and stopped every 2.5% stretch for imaging after relaxation time. Image processing strategy consists in quantifying locally 1st/ the fiber orientation 2nd/ local and global movements of the fiber network.
Results - The acellular matrix network has been used to check the orientation during loading from 0% to 20% stretch. The local re-orientation is quantified, and results show fiber re-orientating in the direction of loading. Strain component in the direction loading and transverse to it are calculated from Digital Image Correlation-based displacements. When seeding fibroblasts, the tissue becomes stiffer, from 8.2 to 122.2 kPa and the Poisson ratio smaller, from 0.375 to 0.214 (1.5% stretch).
Discussion - Results revealed that adding cells during manufacturing induced structural changes, which provided higher mechanical properties. Moreover, senescence models exhibited lower mechanical properties. This multiscale approach was efficient to characterize and compare skin equivalent samples and permits the first experimental assessment of the Poisson's ratio for such tissues.