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NEW APPROACH TO STUDY SKIN VISCOELASTIC THROUGH SURFACE WAVE PROPAGATION, USING NON DESTRUCTIVE IN VIVO TESTING

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Summary: Characterizing human skin using in vivo testing is quite a challenge. Traditionally, ex vivo tests are performed but as a living tissue, some information is lost. More recently, alternative methods were used for in vivo characterization. In our new method, we aim at characterizing skin with contact - less excitation and characterizing its rheology in vivo. To achieve that, we firstly investigate in vivo skin viscosity with a device developed at our laboratory; then we explore the surface wave propagation; and finally, we study the in vivo skin rheology through the wave propagation. First, we investigate in vivo skin rheology and, in particular, its viscosity. Traditionally on viscoelastic polymers, a creep recovery essay is carried out to characterize their rheology. We adapt this test to the skin for our approach: it is conducted on human skin with an applied constraint of 2.5 kPa during 300ms. As a result, we obtain a stress-strain curve. This curve is used to run an optimization routine that outputs the viscoelastic parameters of the tested sample. To describe creeping phenomena, we use a generalized Kelvin Voigt model, which is suitable to depict a creep response. Then, we explore the surface wave propagation. To successful observe the surface wave propagation, we use a harmonic solicitation. To carry out this test, we develop a device generating a blast od air impacting the skin. This blast is lasting 10ms and is equivalent to a harmonic solicitation of 100Hz. The stress, applied on the skin, is so brief that a surface wave is produced. We then measure this propagating surface wave. To compare a viscoelastic and a purely elastic material, we develop a numerical model to reproduce this test. Finally, this approach accesses the effect of the viscosity on the surface wave. Finally, we study the skin rheology using data extracted from the wave propagation. Inspired by geophysicists techniques, we compute a spectral analysis of the surface wave recorded. The analysis yields the main parameters of the wave propagation: phase velocities and attenuations. With these two parameters, it is possible to recreate the complex wavenumber of the surface wave, used after to compute the complex wavenumber of the shear wave. Then, we can express, thanks to the shear wave, the complex shear modulus and its complex viscoelastic moduli: the storage and the loss modulus. With these two, we write a fitting procedure to retrieve the viscoelastic parameters using any constitutive equation. To conclude, we create a new approach to characterize skin viscoelasticity. This approach is revealing the quasi - static behavior of the skin, using a creep - recovery test and its dynamic behavior, using surface wave analysis.