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Lessons learned in the past for a brighter future for pressure ulcer prevention and management

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ABSTRACT BOOK

STINTS6

TOWARDS ULTRASOUND BASED MECHANICAL CHARACTERIZATION OF SKIN AND SKIN DISEASES

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Introduction: Studies have shown that measuring the biomechanical change of skin can be used to detect skin diseases such as Pressure Ulcer (PU) [1,2]. The objective of this study is developing an experimental setup to estimate the mechanical properties of skin based on quasi-static ultrasound (US) elastography, a technique used to investigate the biomechanical properties of tissue (such as strain, modulus) non-invasively.[3].

Methods: For an in vitro feasibility test, a 15 weight percent (wt%) Polyvinyl alcohol (PVA) phantom was created. For acoustic scattering, 3 weight percent Silicon carbide was added to the PVA mixture. Next, a linear array 10 MHz US probe was used to both compress and image the phantom simultaneously. To create an heterogeneous deformation field and measure the load, a water filled, small diameter balloon, which is attached to a pressure sensor, was positioned between the probe and the upper surface of the artificial tissue. During compression, the hydrostatic pressure that is present inside the balloon is transferred to the tissue, which was stored digitally. Ultrasound imaging was performed during compression. The displacement field in the vertical direction was estimated by analyzing the radio-frequency (RF) ultrasound data using a 2-D block matching technique, and converted into strains.

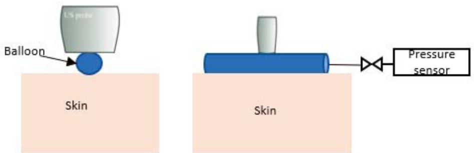

Figure 1: Schematic view of the experimental setup

Results: Figure 2 shows the undeformed and deformed state of the PVA phantom and the change on the hydrostatic pressure inside the balloon during the indentation. The blue grid overlay is based on the displacement estimation for each node. The strain field of the region of interest can be seen on the Figure 3.

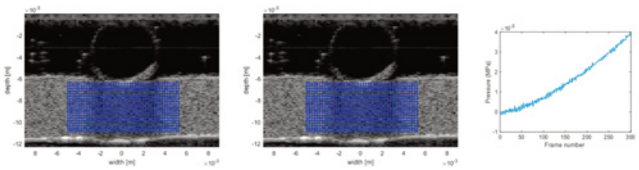

Figure 2: B-mode US images of the balloon and phantom before indentation (a) and after indentation (b). The reflection below the grid results from the plate under the phantom; c) the pressure over the consecutive US images

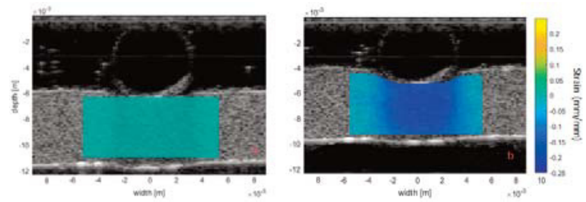

Figure 3: Strain field on phantom before indentation (a) and after indentation (b)

Conclusions: Displacement and strain filed calculation, which is one of the main parameters to calculate the skin modulus, throughout the compression was succeed. The stress, other main parameter for modulus, was acquired via pressure sensor assuming the pressure inside the balloon is equal to the pressure on the tissue. However, the result can be verified with further studies, such as mechanical tests (compression, tensile test) and Finite Element Analysis.

References:

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