FEASIBILITY OF USING 2D ULTRASOUND DATA FOR BUILDING A PERSONALIZED NUMERICAL MODEL OF THE SACRAL REGION FOR THE EVALUATION OF THE SUBJECT-SPECIFIC RISK OF SACRAL PRESSURE ULCER

Ekaterina Mukhina[1, 2], Pierre-Yves Rohan[2], Nathanael Connesson[1], Yohan Payan[1]

[1] Laboratoire TIMC-IMAG, Université Grenoble Alpes, La Tronche, France
[2] Institut de Biomécanique Humaine Georges Charpak, Paris, France

Introduction: The motivation of this work is to evaluate the correlation between mechanical and biological risk factors to evaluate subject-specific risk of sacral Pressure Ulcer (PU). From the mechanical perspective, the high internal strains were proven to be a cause of the PU onset [1], while from the biological perspective, inflammatory biomarkers showed correlation with tissue deformation [2]. The global objective is to interrogate the following concept: can inter-individual variability in biological response be partly explained by the variability in internal soft tissue mechanical response to external load? As a first step, this abstract will focus only on the mechanical response, validating the concept that it could be quantified using the B-mode 2D ultrasound (US) image.

Methods: 2D US data for the subdermal tissues in sacral region was acquired for one healthy volunteer (male, 33y.o., BMI=26.1kg/m2) laying in the prone position. A linear probe combined with a custom-made load sensor following the protocol described in [3] was used as an indenter. Fourteen loading cycles were performed. Geometry of a 2D subject-specific finite element model was then built based on the frames recorded for one cycle. Soft tissues behavior was represented by first order Ogden hyperelastic material model. Personalization of the tissue elastic properties was derived using an inverse procedure.

Results: Shear strain was chosen as a parameter for the mechanical response quantification, since it previously showed correlation with the internal tissue damage [1]. Personalized model was used to evaluate the maximum shear strain area, which occurred in the region of fat/skin contact.

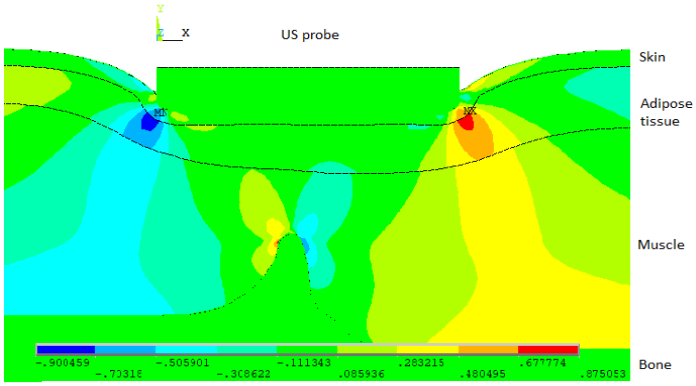

Figure: Shear mechanical strain

Conclusions: This work shows the feasibility of using 2D US data for building a subject-specific numerical model to evaluate the mechanical response of soft tissues induced by the load. Ultrasound thus allows obtaining anatomical data and is accessible in clinical setting. Future work will include the comparison of the above results with the ones obtained using an MRI, reliable but costlier technique.

Acknowledgements: This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No. 811965.

References:

[1] Ceelen KK et al. (2008). Compression-induced damage and internal tissue strains are related. *Journal of Biomechanics*,*41*(16),3399–3404.

[2] Soetens JFJ et al. (2019). The expression of anaerobic metabolites in sweat and sebum from human skin subjected to intermittent and continuous mechanical loading. *Journal of Tissue Viability*. Tissue Viability Society.
[3] Fougeron N et al. (2020). Combining Freehand Ultrasound-Based Indentation and Inverse Finite Element Modelling for the Identification of Hyperelastic Material Properties of Thigh Soft Tissues. *Journal of Biomechanical Engineering*,*c,1*–22.