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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

STINTS2

STRAIN CALCULATION FROM MRI IMAGE REGISTRATION: AN APPLICATION FOR PRESSURE ULCER PREVENTION

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Introduction: Pressure ulcers are a severe disease affecting patients that are bedridden or on wheelchair bound for long periods of time. These wounds can develop in the deep layers of the skin of specific parts of the body, mostly on heels or sacrum, making them hard to detect in their early stages. Prevention could be possible with the implementation of patient-specific Finite Element (FE) models to calculate dangerous levels of strains in the deep tissues that could trigger a pressure ulcer [1]. However, validation of such FE models is a complex task and the current implemented techniques offer only a partial solution of the entire problem considering only external displacements and pressures, or cadaveric samples [2]. In this abstract, we propose an in vivo technique that will be implemented for evaluating the simulations provided by a FE model of the human heel. This solution is based on the 3D non-rigid registration between two Magnetic Resonance (MR) images (one with heel at rest and the other one after applying a surface load below the heel) that is used to estimate tissue in vivo internal strains.

Methods: A Magnetic Resonance-compatible device has been designed to apply external loads on the heel while acquiring MR images (Figure 1). The deformation field between the undeformed and deformed configuration is computed with non-rigid registration techniques using the Elastix toolbox [3] (Figure 2). The Green-Lagrange strain filed is subsequently calculated from the obtained deformation map.

Results: The MR-compatible device permitted to obtain good quality images (see figure 2) allowing for a reliable image registration. For the heel application, the location and levels of maximal strains resemble the expected results found in previous studies implementing FE models of the heel [1].

Conclusions: The implemented technique adds a useful tool for better understanding the propagation of strains in heel deep tissues that could generate pressure ulcers. This MRI compatible protocol could therefore be implemented to evaluate performances of orthotics and dressings aiming for preventing pressure injuries. Finally, strain estimations through image registration offers a promising technique for evaluating FE models for biomechanical applications.

Figure 1: MR-compatible compression device in the MR experiment.

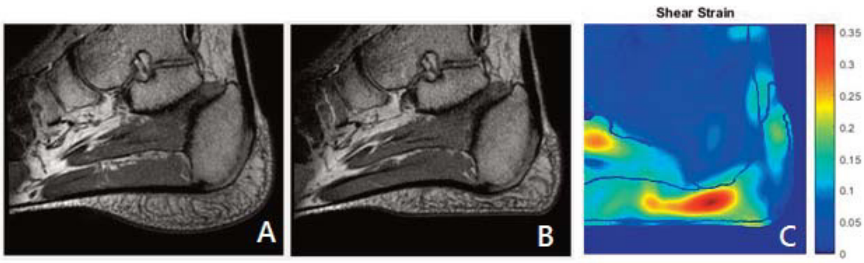

Figure 2: Image A shows the MR acquisition for a heel at rest. Image B shows the heel compressed by a plate applying 140 N of normal force. These two images are used to run the registration and subsequently calculate the resulting shear strains shown in image C.

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