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DEVELOPMENT OF AN MRI-COMPATIBLE INDENTATION SYSTEM TO CHARACTERIZE THE MECHANICAL RESPONSE OF SACRAL SOFT TISSUES FOR PRESSURE ULCER PREVENTION

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Introduction: The prevention of Pressure Ulcers (PU) remains a major health challenge because of its human and financial cost due to prolonged hospitalization and reduced quality of life for the patients. Many subject-specific finite element models have been developed to assess the risk of PU. In particular, the localization of mechanical strain within soft tissues has proved a valuable tool to evaluate soft tissue injury risk [Ceelen et al., 2008]. However, there is a lack of experimental validation of the strain predicted by such models. Based on the methodology developed in a previous study [Trebbi et al, 2022], the objective of this contribution is to experimentally characterize the response of sacral soft tissues under realistic loading (bedrest) using MRI and a custom-made set-up.

Methods: One healthy subject (male, 35y.o., BMI=28.1kg/m2) participated in the experiment. A custom-made set-up was designed (figure 1) to apply a realistic loading on the sacral area during the MRI. Five positions were recorded: prone, supine unloaded, supine loaded (1kg loading and then 1.5kg) and supine fully loaded (bodyweight). Digital volume correlation was performed with the Elastix library between the supine unloaded and the supine loaded 1kg position. The deformed volume was obtained by applying the displacement field computed to the initial segmented volume.

Results: The MRI images in the supine unloaded and loaded position (1kg loading) are given in figures 2(a) and 2(b) respectively. The results of the segmentation of the gluteal muscle are overlaid in both configurations. The gluteal muscle volume in the undeformed configuration was estimated as 1020cm3. This is consistent with previous results reported in the literature [Sonenblum et al., 2014]. Preliminary results show a change of volume of 4.4% for the gluteus maximus in the supine loaded position (1kg loading).

Conclusions: This work is important because the evaluation of the internal soft tissues response under realistic loading has never been evaluated experimentally before. The next step is to compute the mechanical strain from the displacement field estimated with Elastix as a surrogate measurement of soft tissue injury risk. Perspective work also include the estimation of the uncertainty of segmentation and the development of methods to alleviate the process.

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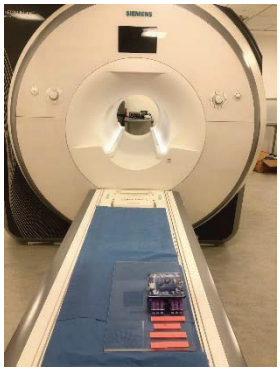

Figure 1) MRI compatible custom-made set-up capable of applying a controllable force on one buttock using weights and pulleys.