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PATIENT-SPECIFIC MODEL GENERATION FOR FOOT PRESSURE ULCER PREVENTION

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Deep pressure ulcers (PU) appear internally when pressures applied on the foot create high internal strains nearby bony structures. Monitoring tissue strains on a patient-specific basis is therefore important for efficient PU prevention. To generate a biomechanical foot model adapted to patients' morphology and where strains can be monitored, our method deforms a foot atlas to conform it to the contours of the patients' feet in segmented medical images [Bucki]. Our atlas is a model composed of rigid bones, joined by ligaments and muscles, and surrounded by a Finite Element mesh representing the soft tissues. Three new patient models were created from the registration of our atlas with three datasets. The maximal Von Mises strains and "cluster volumes" (i.e. volumes of contiguous elements with strains above a given threshold) were measured within eight functionally meaningful foot regions after simulating these foot models during unipodal stance. This regionalization is automated for enhanced clinical interpretation of the simulations. The figure shows the variability of these two criterions in terms of location among the three patients. The results also confirm the influence of the foot anatomy on the risk of PU.
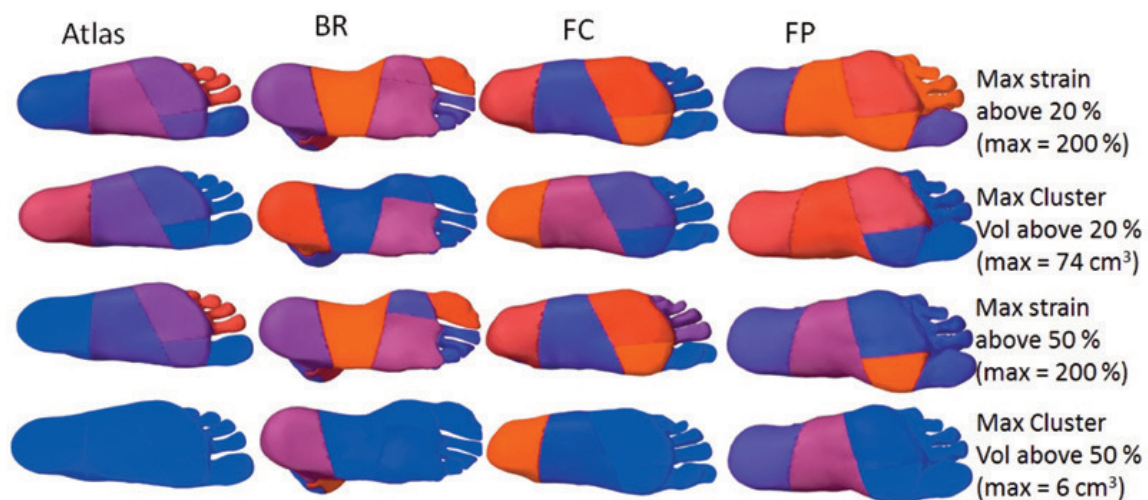

Figure Caption: Maximum VM strain and maximum cluster volume repartition for each anatomical region and for each patient, according to the strain thresholds of 20 and 50% [Loerakker]. For the strains, red colors mean strains above 200%. For cluster volume, red colors mean volume above 74cm3 for strains above 20%, and volume above 6cm3 for strains above 50%.

References:

Bucki et al., Clinical workflow for personalized foot pressure ulcer prevention, Med. Eng. & Phys. 2016.
Loerakker et al., The effects of deformation, ischaemia and reperfusion on the development of muscle damage. J. App. Phys. 2011.