PATIENT-SPECIFIC REGIONALIZATION FOR FOOT PRESSURE ULCER PREVENTION

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Background and Aims

Foot pressure ulcers (PU) mainly result from excessive pressure intensity (internal strains above 50% for about 10 minutes) or prolonged compression (internal strains above 20% for about two hours) [1]. It is therefore crucial to monitor the internal strains using biomechanical models combined with skin surface pressure measurements to improve daily examination. This paper focuses on defining the regions with highest strains and analyzes the variations between patient morphologies.

Methods

Our biomechanical Finite Element (FE) foot atlas [2] is divided into eight anatomical regions: Achilles tendon, ankle, heel, medial foot, first metatarsus, four other metatarsi, hallux, and four other toes. This model is deformed using rigid and elastic transformations [3] to fit three patients' morphologies obtained from Computed Tomography scanners. These four models are used to simulate bipedal standing.

Results

The simulations report high Von Mises (VM) strains variations from one patient to another between regions, cf. figure. The maximum "strain cluster volume" (defined as the volume of the largest group of adjacent FE nodes exhibiting VM strains over the thresholds mentioned above) is always located in the heel region, and ranges between 51 and 74cm^3 for VM strains above 20% and between 0 and 21cm^3 for VM strains above 50%.

Conclusions

Given the morphological differences and the large variations observed in cluster volumes, an accurate representation of the external and internal structures is necessary to precisely estimate the regions with highest internal strains. This confirms that patient-specific modelling is required in PU prevention.

References

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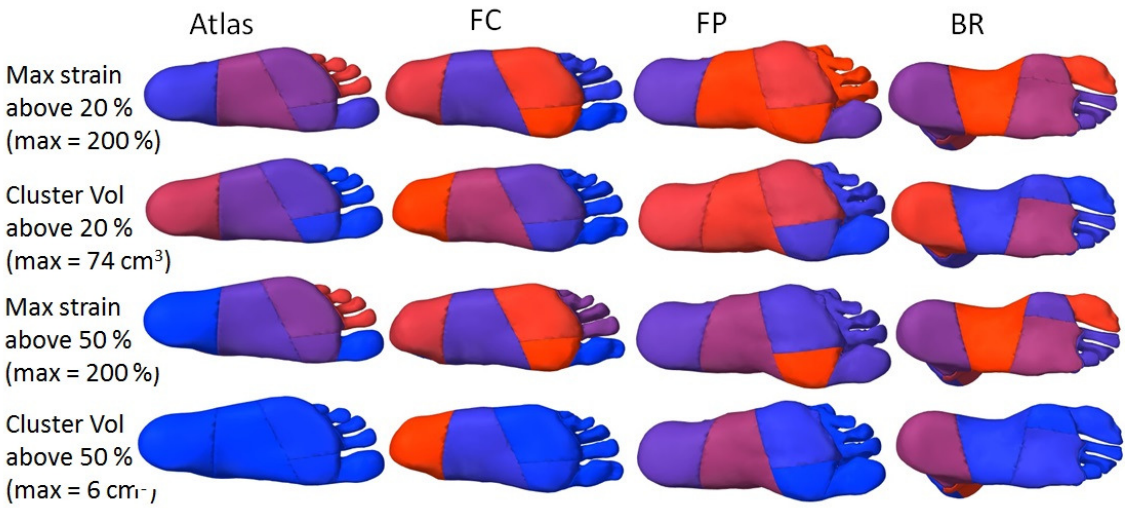
[3] Bucki M. et al. MEDIA, 14:303-317, 2010.


Atlas
FC
FP
BR
Max strain above 20 % (max = 200 %)
Cluster Vol above 20 % (max = 74 cm3)
Max strain above 50 % (max = 200 %)
Cluster Vol above 50 %