“STRAIN CLUSTERS” ANALYSIS TO CHARACTERIZE THE RISK OF PRESSURE ULCER: APPLICATION TO HEEL ULCERS

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Background and Aims

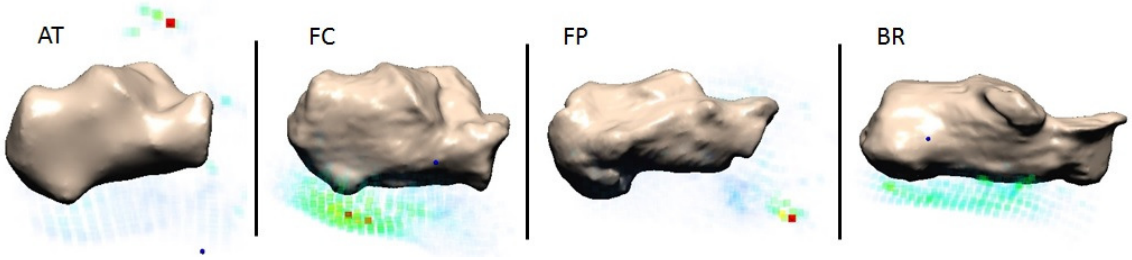
Foot pressure ulcers (PU) mainly result from excessive pressure intensity (internal strains above 50% for about 10 minutes) or prolonged compression (internal strains above 20% for about two hours) [1]. It is therefore crucial to monitor the internal strains using biomechanical models combined with skin surface pressure measurements to improve daily examination. Peak strains have been studied so far, but monitoring the volume of tissues over the above-defined strain thresholds could be more efficient.

Methods

A biomechanical Finite Element foot model was elaborated to analyze the internal strains [2]. A new criterion, defined as “cluster volume”, was introduced by considering the volume of the largest group of adjacent nodes exhibiting a Von Mises (VM) strain over the 20 and 50% thresholds.

Results

Whereas the simulations report huge variations between patients for maximum VM strains (from 161 to 399% in various foot regions), the maximal cluster volume is always located in the heel region, with values ranging between 51 and 74cm^3 for VM strains above 20%, and between 0.2 and 21cm^3 for VM strains above 50%. The attached figure shows the main cluster volume for four patients, around the calcaneus, and the maximal VM strains location (red dot, around 110%), not always below the heel.



Conclusions

These results suggest that only monitoring the maximum VM strain is not adequate to evaluate PU risk, due to numerical instabilities. On the contrary, cluster localization within the foot provides valuable information on the regions where lesions could appear, refining prevention strategy.

References

[1] Loerakker S. et al., J. Appl. Phys. 111(4):1168-77, 2011.
[2] Luboz V. et al., CMBBE: Imag. & Visu. 2(4)189-196, 2014.