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ABSTRACT BOOK

STINTS4

COMPUTATIONAL MODELING OF SAGGY SKIN: THE EFFECT OF SKIN PROPERTIES ON SKIN FOLDING FORMATION

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Introduction: Formerly overweight patients often develop saggy skin due to massive and fast weight loss1. This saggy/folded skin causes physical and psychosocial discomfort such as limited mobility, poor body image, and pressure ulcers (PU). The PU locate between skin folds due to unrelieved pressure, poor vascularization, and changes in the microclimate2. Therefore, in post-bariatric surgery, 62.4% of patients return for body-contouring surgery to avoid the aforementioned complications1. The occurrence of skin folding might be related to the variations in material properties and thickness of the skin among formerly overweight patients3. The goal of our study is to understand the influence of material and structural parameters on skin folding.

Methods: Using computational modeling, we investigated the influence of skin properties (e.g. stiffness ratio between dermis and hypodermis, skin thickness) on the skin folding morphology via developing a biomechanical growth model. This model was implemented in a software4. The bilayer system, made of dermis and hypodermis, was defined as a compressible Neo-Hookean hyperelastic material via a user-defined material subroutine (VUMAT). The hypodermis shrinkage triggers the skin folding.

Results: The stiffness ratio was varied in the range 0.7-40 to account for differences in stiffness measurements of the dermis5(Fig. 1). All simulations were performed for skin thicknesses of lean (1.35 mm) and formerly obese people (2.84 mm), (Fig. 1.a and .b) respectively3. Results showed large variations of the fold number and wavelength at different stiffness ratios. Generally, the number of folds decreased and the fold wavelength increased with increasing stiffness ratios. Additionally, for a ratio higher than 20, the skin folds were predicted to go deep into the hypodermis where the skin is in contact with itself. The skin thickness was also predicted to affect the surface morphology. Simulations with a thick dermis showed a lower number of folds and a larger wavelength compared to thin dermis simulations. The weight-loss percentage, at which the skin starts to buckle, decreased with increasing stiffness ratios. Particularly, for low ratios, the buckling was predicted to start at about 60% of weight loss, while this percentage dropped to 28%-23% for high stiffeness ratios (20-40).

Conclusions: Our computational model predicted that large differences in stiffness between the dermis and hypodermis are associated with a higher risk of developing skin folding. The proposed model may help in the prediction of a target amount of weight loss of the patients, to prevent PU between skin folds in post-bariatric surgery.

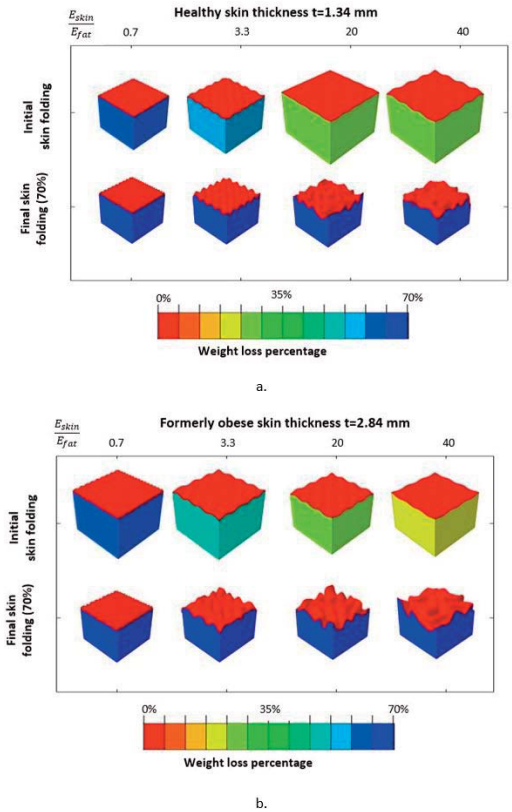

Figure 1: Skin folding representation.

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