IN VIVO MECHANICAL CHARACTERIZATION AND TISSUE-SCALE MODELLING OF KELOID AND SURROUNDING HEALTHY SKIN

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Abstract

Keloids are fibrous benign tumors of the human skin caused by cutaneous trauma. They grow on some specific anatomical sites (arm, abdomen, sternum, *etc.*), subjected to natural mechanical load due to peripheral stress of the tissue and to repeated postures, or to anatomical singularities [1]. Genetic, biological and mechanical factors have an important impact on the occurrence and the propagation to theses tumors. A tight collaboration between researchers from clinical science, biology, mechanics, mathematics and computational mechanics, has been established to analyze and understand the mechanical effects on theses cutaneous alterations. Starting from a multimodal investigation on a patient, a numerical pipeline consisting of several open-source frameworks has been developed leading to stress field analysis in a domain composed of a keloid and surrounding healthy skin. The main objective through this methodology is to conceive specifications of a customized medical device to confine keloid growth or prevent against its growth (Figure 1). In this congress, the experimental and computational contributions of this project achieved at that time are presented as follows : (i) Mechanical characterization with extensometer [2] and ring suction tests [3] combined to medical imagery technique, (ii) Bi-material parameters identification via inverse method of healthy and pathological soft tissues from *in vivo* uniaxial test coupled with digital image correlation and finite elements model (FEniCS-based open-source framework) [4], (iii) Mechanical analysis of multiaxial test of ring suction using digital image correlation to characterize the anisotropy of the skin [5], (iv) Mesh optimization by error estimators [6] applied to a heterogeneous soft tissue, (v) Uncertainties quantification associated with mechanical and topological parameters of 2D and 3D models. The summary of these works in tissue-scale is part of a global project of multi-scale modelling and analysis of mechanical factors influencing the fibroproliferative cellular kinetics.

References

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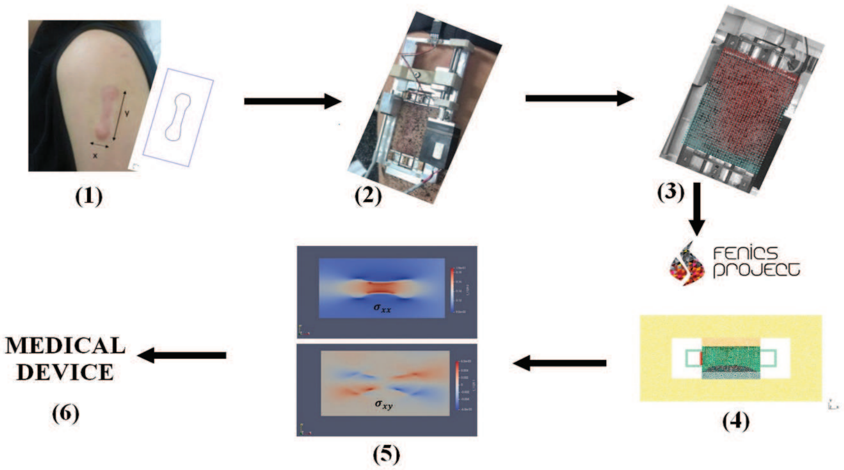

Figure 1: Numerical pipeline: from patient to medical device. (1): Keloid modelling. (2) Uniaxial extensometer test. (3) Digital Image Correlation. (4) Finite Element Model Updating to identify material parameters. (5) Stress field quantification. (6) Medical device to prevent against keloid growth.