MECHANICAL CHARACTERIZATION OF HUMAN SKIN FROM *IN VIVO* TESTS AND SIMULATION OF RECONSTRUCTIVE SURGERY

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A comprehensive computational/experimental procedure has been formulated to characterize the mechanical properties of human skin from *in vivo* tests and simulate reconstructive surgery. The procedure uses experimental measurements obtained through an *in vivo* technique developed by Raposio and Nordstrom [1] and a computational model formulated within the framework of finite strain hyperelasticity that is used to calibrate the constitutive model, identify the natural state of the skin and simulate reconstructive surgery.

The *in vivo* experimental technique consists of the incision of the skin, the undermining of an area surrounding the incision, the application of two monotonically increasing forces (tangential to the skin flap and orthogonal to the incision) and the measurement of the corresponding displacements at the midpoint of the incision. The tests can be performed within reconstructive procedures and have been applied to scalp flaps in [1]. In order to characterize the mechanical response of the skin tested in [1], the scalp flaps have been represented in the theoretical model as homogeneous, isotropic and hyperelastic plane membranes (the assumption of isotropy follows from the observed absence of material symmetries in the biological structure of the scalp). The phenomenological model proposed by Tong and Fung [2], which defines the elastic potential in terms of the Green-Lagrange strain components and five constants to be determined experimentally, has been used to describe the skin. In order to simulate the complex geometry and loading conditions of the system, the domain has been discretized and the problem solved using the finite element method.

The parameters of the constitutive model and the principal stretch of the skin in its natural state have been derived through the minimization of an objective function depending on the residuals between the experimental data and the theoretical predictions [3]. An investigation has then been conducted to examine the quality of the estimate. The investigation highlights that one of the model's parameter is undetermined. An improved experimental methodology is proposed to enhance the information content of the experimental data and allow the identification of all model parameters with sufficient accuracy. The model is then applied to simulate reconstructive surgery procedures and investigate the influence of the size/shape of the excision and the undermining on stresses on sutured wounds.

REFERENCES

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