Characterization of mechanical properties of dermis and fat in vivo

Characterization of Mechanical Properties of Dermis and Fat in vivo

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Introduction

Human skin is a complex tissue consisting of several distinct layers, each consisting of their own components and structure.

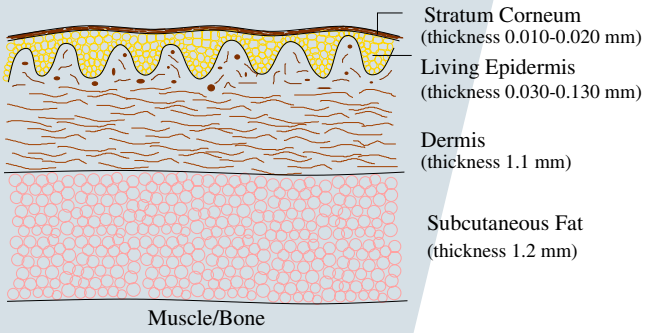

Figure 1 *Schematic view of cross-section of human skin, showing 4 layers (thicknesses for volar forearm).*

To gain a better insight of the overall skin behaviour during shaving, the mechanical behaviour of the different layers will be studied.
This work is focussed at the dermis and fat layer.

Objective

Development of experimental setup and numerical model to evaluate and simulate the mechanical properties of human dermis and fat in vivo.

Experimental Setup

A 20 MHz ultrasound system (Dermascan, Cortex, DK) is coupled to a pressure chamber with an aperture size of 8mm. The chamber is attached to the skin with double adhesive tape and filled with water. Application of an underpressure (suction) in the chamber with a syringe causes an uplift of the skin. Applied pressures are measured with a pressure sensor. Resulting displacements are obtained from the ultrasound images.

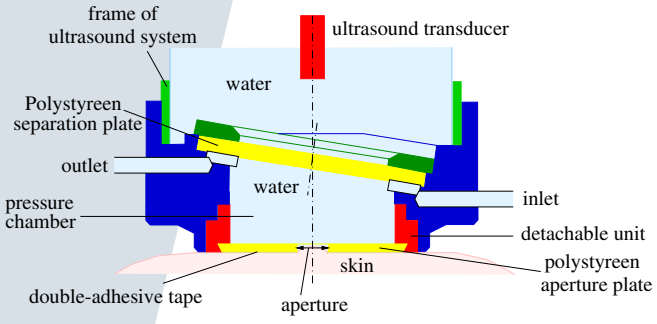

Figure 2 *Schematic view of experimental setup. The pressure sensor is located behind the water outlet.*

Experimental Results

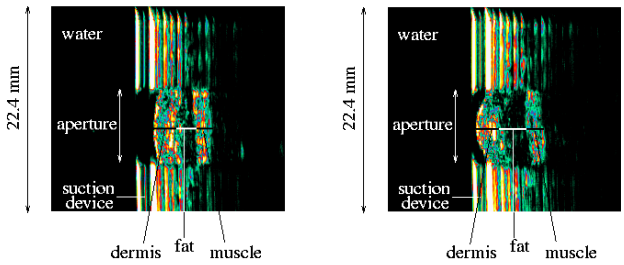

Figure 3 *Forearm skin and fat at atmospheric pressure (left) and at 37 mbar underpressure (right).*

37 mbar underpressure results in a fat thicknesses increase from 1.15 to 1.58 mm, dermal thickness is unchanged at 1.21 mm and the skin surface displacement is 0.65 mm.

Numerical Model

The experiment is simulated with a two layer FEM model (MARC). Dermis and fat are simulated with Mooney material behaviour. Material parameters are obtained by comparison with the experimental results. Manually fitting results in $C_{10,fat} = 20$ Pa and $C_{10,dermis} = 50$ kPa.

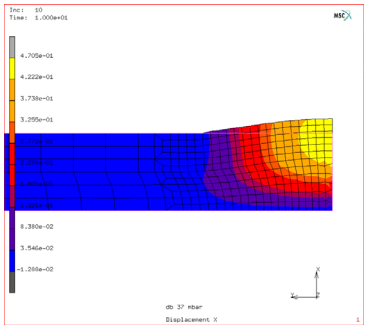

Figure 1 *Enlarged part of axisymmetric 2-layer FEM model showing x-displacements at 37 mbar suction.*

Discussion

The obtained material parameters for dermis are consistent with results from earlier suction experiments [1].

Future Work

A micro pump will be added to gain better control. Pressures-displacement curves will be measured for various aperture sizes. The constitutive model has to be extended to account for nonlinear behaviour and PARFIT, a parameter estimation tool, will be employed.

References:

[1] Diridollou, S. *et al*: *In vivo model of the mechanical properties of the human skin under suction* Skin Research and Technology, 2000:6:214-221

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