Biomechanical evaluation of skin and melanocytic naevi

E. Cutrì[1], G. Franzetti[1], F. Crippa[1], E. Montin[2], G. Spadola[3], A. Testori[3], L. Mainardi[2], and G. Pennati[1]

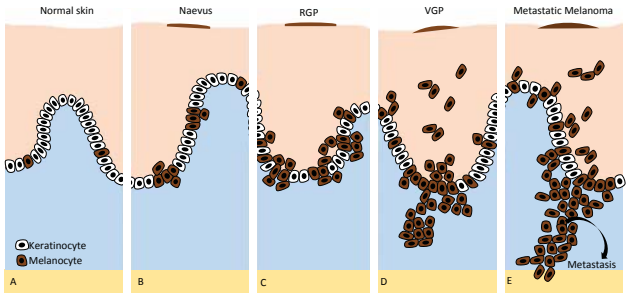
[1]Laboratory of Biological Structure Mechanics, Chemistry, Materials and Chemical Engineering Department "Giulio Natta", Politecnico di Milano, Milan, Italy.

[2]Department of Electronics, Information and Bioengineering, Politecnico di Milano, Milan, Italy.

[3]Dermatoncological Surgery Division, Istituto Europeo di Oncologia, Milan, Italy.

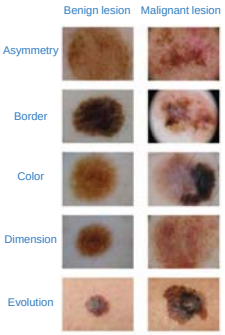
Clinical background & motivations

Malignant melanoma is a highly aggressive skin tumor causing the 75% of skin cancer-related deaths [1]. The 5-years survival rate ranges from 15% if lately detected to 99% if early detected [2]



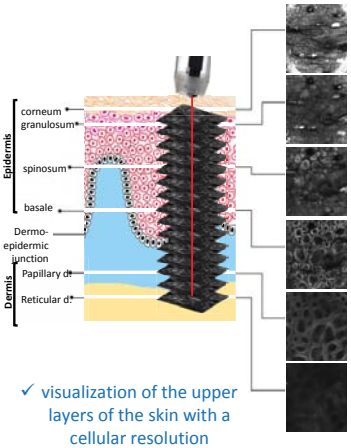
Radial growth phase (RGP): melanocytic neoplastic cells spread across the epidermis and the DEJ and infiltrate only the superficial dermis (C); vertical growth phase (VGP): cells invade the dermis and aggregate in intradermal cell nests (D) and the metastatic melanoma reaching the lymphatic and blood's circulations and metastasizing to other organs (E)

- Dermoscopy



✓ visual diagnosis based on the ABCDE rule

- Confocal laser scanning microscopy (**CLSM**)



✓ visualization of the upper layers of the skin with a cellular resolution

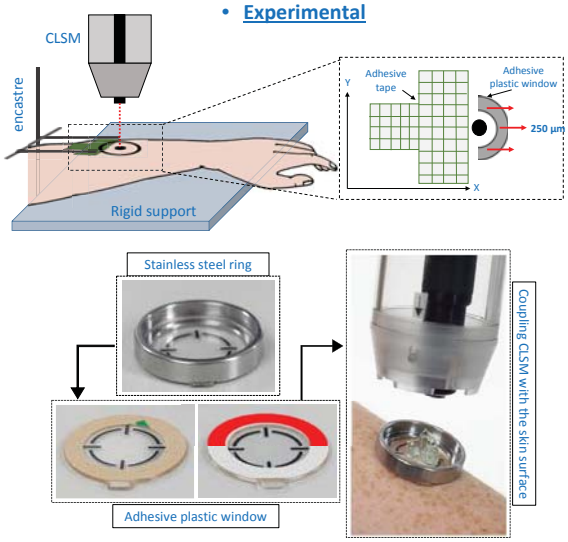
Biopsy & histological analyses mandatory for final diagnosis

A modification of the mechanical properties of biological tissues during the development of cancers such as carcinoma [3], [4] or melanoma [5]-[7] assessed in literature

Biomechanical characterization of the properties of the **skin** and **melanocytic naevi** combining **experimental** and **computational** analyses

Materials & Methods

- **Experimental**

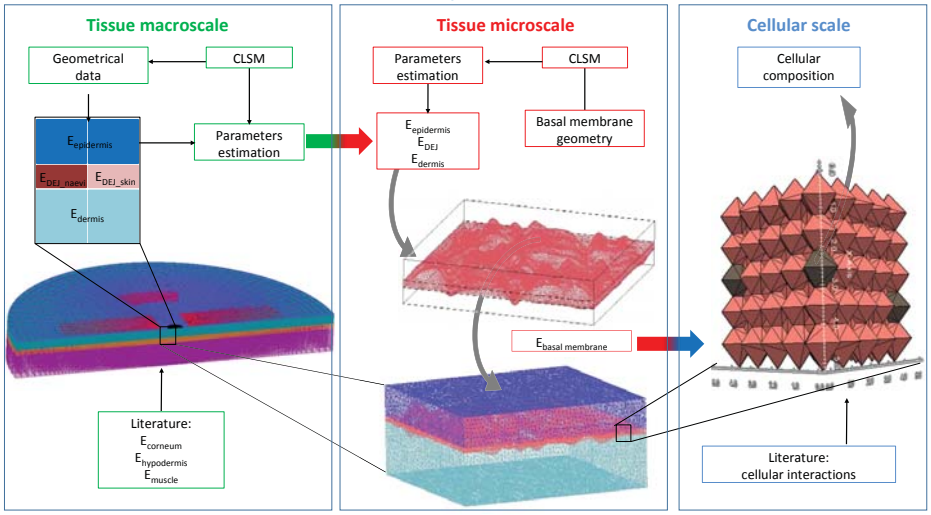


Experimental setup :

- 6 healthy volunteers
- CLSM VivaScope® 1500
- Adhesive tape Opsite Flexigrid
- Dorsal forearm
- In house set up

- Stack: 500 x 500 x 152 µm
- In-plane resolution: 0.5 x 0.5 µm
- Superficial displacement: 250 µm
- Undeformed & deformed configurations
- Registration strategy [8]

- **Computational**



Reproduces the experimental conditions*

- Each layer hyperelastic neo–hookean
- Isotropic & incompressible
- Constant thickness
- B.C. superficial displacement of 250 µm

Reproduces the CLSM stack*

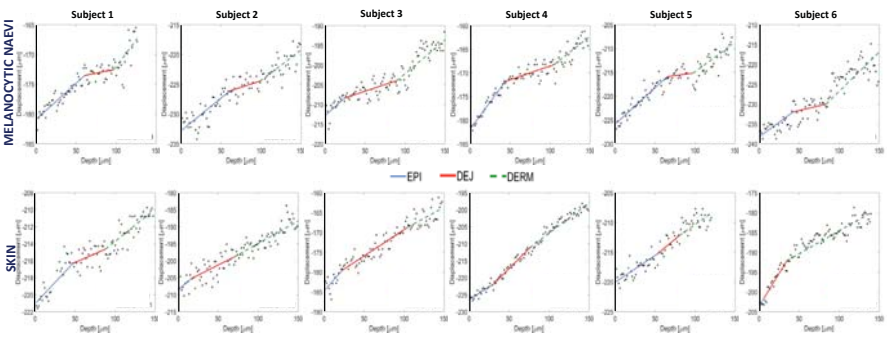
- Each layer hyperelastic neo –hookean
- Isotropic & incompressible
- Subject specific geometry of the DEJ
- B.C. displacement from macroscale model

Reproduces different ratios of cells†

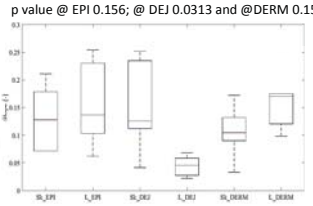
- material parameters from micro scale model
- cells interaction from literature

* Abaqus 6.13 ® (SIMULIA, Dessault Systèmes, France); † Chaste (Cancer, Heart And Soft Tissue Environment, University of Oxford).

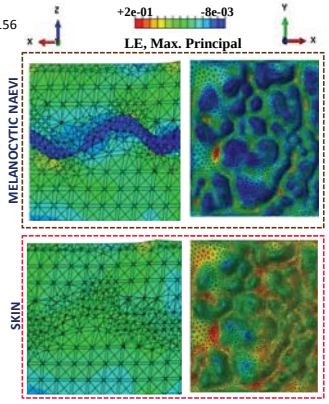
Results & discussion



p value @ EPI 0.156; @ DEJ 0.0313 and @DERM 0.156



Skin layers	Stiffness [kPa]
Corneum	100.0
Epidermis	2.5
DEJ	2.0
DEJ naevus	10.0
Dermis	1.5
Hypodermis	1.0
Muscle	80.0



Conclusions

The combined approach here proposed allowed to obtain the experimental transverse displacement in the skin and skin lesions of healthy volunteers. The multiscale model provided important information on the modification of the mechanical properties in the skin lesion with respect to the normal skin. Such methodology represents an interesting and suitable tool to be applied in the investigation of the melanoma to obtain further understanding of such pathology as well as indications to support clinical diagnosis

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