Single cell mechanics

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Introduction

The field of cell mechanics investigates how cells generate, sense and respond to mechanical loads. The mechanical properties of cells are a direct consequence of their protein structure and thus intimately related to their biochemistry and genetics. The aim of our study is to investigate the response of individual muscle cells under compression (figure 1) in order to get more insight in muscle damage during pressure sore development.

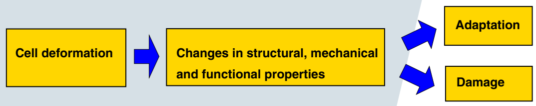

Figure 1 *Effects of mechanical loads on cells.*

For this purpose techniques are developed to apply mechanical loads on individual cells and to detect both cell deformations as well as changes in mechanical and structural properties during compression.

Methods

Cell Visualization

Cell deformation and structural changes are observed using a confocal laser scanning microscope (CLSM). With the aid of custom made image analysis software, geometric quantities such as volume and surface area are calculated (figure 2).

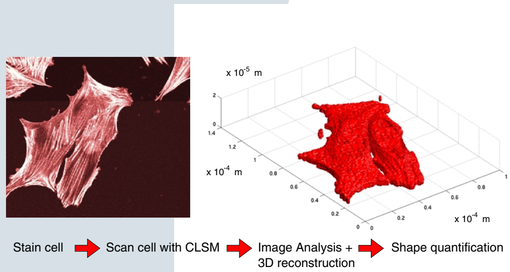

Figure 2 *CLSM image of a cell and the computed 3D image.*

Cell compression

A loading device has been designed which compresses single cells statically or dynamically and measures their stress-strain relationships (figure 3).

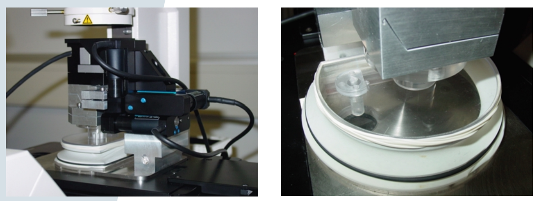

Figure 3 *The single cell loading device.*

The device consists of (figure 4):

- ☐ a glass tip for cell compression
- ☐ a tilting table to ensure parallelism of the tip and the cover glass
- ☐ a force transducer (maximum range: 500 μN, resolution: 10 nN)
- ☐ a dynamic piezo-system (maximum range: 100 μm, resolution: 5 nm)
- ☐ three micromanipulators (maximum range: 15 mm, resolution: 0.05 μm)
- ☐ A climate chamber for control of temperature, humidity and CO_2 concentration.

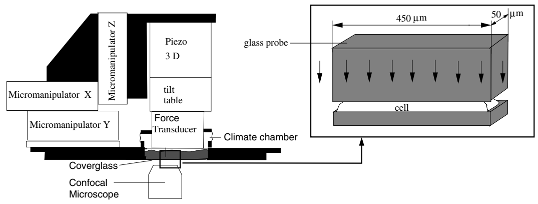

Figure 4 *Schematic representation of the single cell loading device.*

Results

The device has been characterized thoroughly and first experiments are conducted on single C2C12 myoblasts. During these experiments a cell was deformed until it bursted. A typical example is shown in figure 5.

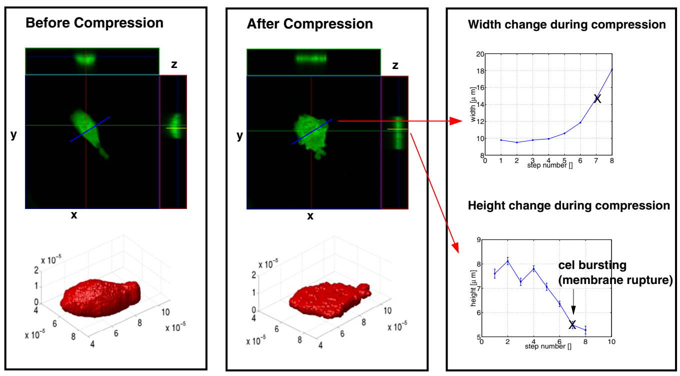

Figure 5 *Deformation of a single cell.*

Discussion and Future Work

First experiments demonstrated that the developed techniques are capable of deforming single cells and quantifying cellular shape changes during compression. Future experiments will include both force and long term measurements, which will give us more insight in muscle damage processes as a result of compression.

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