Introduction

Many diseases are associated with significant changes in the organization of cytoskeletal and membrane structures of human cells [1, 2]. These cellular modifications affect the mechanical and adhesive properties of the cell (Fig. 1). Thus, cell mechanical properties may be viewed as a biological marker and a diagnostic indicator for the incidence and progression of the disease.

During the process of atherosclerosis, circulating monocytes leave the blood stream and adhere to endothelium. It is postulated that the activation of monocytes by adhesion molecules and the attachment of monocytes on endothelial receptors cause a reorganization of the cell structure and result in a change of their mechanical properties.

Objective

The objective of this work is to study the possibility to discriminate between affected cells and healthy cells on the basis of cell mechanical properties and to distinguish cells in various stages of atherosclerosis.

Methods

Existing methods for mechanical characterization of cells are unable to provide fast screening of circulating cells in a clinical setting due to their complex and time-consuming analyses.

A microfluidic device would overcome the disadvantages of these cell mechanical techniques [3]. In fact, a microfluidic system is appropriate for creating platforms for high-throughput testing of cells since it permits fast mechanical screening of a single cell in a capillary-like microenvironment.

Furthermore, several assays can be run in parallel on a single chip, reducing the experimental time even further.

Future studies

During adhesion, endothelial receptors and immobilized chemokines induce a marked change in the morphology of monocytes. It is postulated that the reorganization of the cytoskeleton depends on the signaling pathways activated by specific protein binding. The response of healthy and diseased cells during adhesion might then be manipulated by coating the microfluidic channel with either non-specific receptor proteins (such as fibronectin) or with specific receptors involved in the development of atherosclerosis (such as selectin). Thus, both the effect of the receptor protein and of the diseased state of the cell might be investigated during cell adhesion.

Cells will be mechanically characterized in the microfluidic channel by compression with an integrated flexible hydraulically actuated membrane. Cell deformation and corresponding mechanical properties will be related to the change in cytoskeletal organization before, during, and after compression.

References