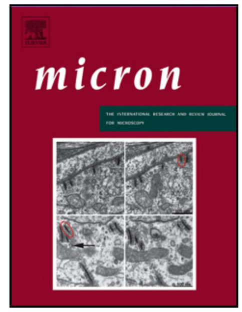
Accepted Manuscript



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PII: S0968-4328(15)30036-6
DOI: http://dx.doi.org/doi:10.1016/j.micron.2015.08.005
Reference: JMIC 2235

To appear in: *Micron*

Received date: 15-4-2015
Revised date: 27-7-2015
Accepted date: 22-8-2015

Quantitative Analysis of Dynamic Adhesion Properties in Human Hepatocellular Carcinoma Cells with Fullerenol

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Highlights ►

► ► The effect of fullerenol ($C_{60}(OH)_{24}$) on the cellular dynamic adhesion properties of living SMCC-7721 cancer cells were first quantitatively investigated by atomic force microscope (AFM) nanoindentation. ► The changing process of the scanning measurements in situ and the obvious topographical difference with and without the treatments by fullerenol were presented. ► The relative changes of relationships responding to the fullerenol treatment, including the dependences of the tip-cell contact area on the elastic modulus and the functional relationship between work of detachment and the tip-cell contact area, were demonstrated. ► The alterations of membrane tether force and tether length due to the fullerenol treatment were observed. ►

Abstract

In this study, the effect of fullerenol ($C_{60}(OH)_{24}$) on the cellular dynamic biomechanical behaviors of living human hepatocellular carcinoma (SMCC-7721) cancer cells were investigated by atomic force microscope (AFM) nanoindentation. As an important biomarker of cellular information, the cell adhesion is essential to maintain proper functioning as well as links with the pathogenesis and canceration. Nonetheless, it is challenging to properly evaluate the complex adhesion properties as all the biomechanical parameters interfere with each other. To investigate the dynamic adhesion changes, especially in the case of the fullerenol treatment, the detachment force and work, adhesion events, and membrane tether properties were measured and analyzed systematically with the proposed quantitative method. The statistical analyses suggest that, under the same operating parameters of AFM, the dependence of adhesion energy on the tip-cell contact area is weakened after the fullerenol treatment and the probability of adhesion decreases significantly from 30.6% to 4.2%. In addition, the disruption of the cytoskeleton resulted in a 34% decrease of the average membrane tether force and a 21% increase of the average tether length. Benefiting from the quantitative method, this work contributes to revealing the effects of fullerenol on the cellular biomechanical properties of the living SMCC-7721 cells in a precise and rigorous way and additionally is further instructive to interpret the interaction mechanism of other potential nanomedicines with living cells.

Keywords: Atomic force microscope (AFM); Adhesion strength; Elasticity; Membrane tether; SMCC-7721 cell; Fullerenol

INTRODUCTION

The biomechanical properties of individual living cells have attracted great interest in recent years. The characterization of biomechanical properties makes an important contribution to the better understanding of dynamic cellular process and the treatment of human diseases. An increasing number of studies have found that the information on cancer development can be derived from the alterations of biomechanical properties, including the cellular cytoskeleton