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AFM adhesion imaging as a prospective tool in the detection of cell's abnormalities and diseases

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Despite considerable advances in understanding the biological and biochemical nature of human diseases, many biophysical aspects of changes in tissue, cells and pericellular coat are still unclear. Here we report an approach based on nanoscale-resolution scanning of surfaces of cells which can be applied to study and diagnostic imaging of various diseases.

Using a combination of resonance and sub-resonance atomic force microscopy tapping modes, ringing mode [1], and machine learning analysis we demonstrated that surface parameters, which are typically utilized in engineering to describe surfaces, can be applied to classify physical alterations of the surface of human epithelial cells. We found that the stepwise in vitro development of cancer (from normal to immortal (premalignant), to malignant) could be associated with the emergence of simple fractal geometry on the cell surface [2, 3]. Further, we applied this method for the detection of bladder cancer by using cells collected from urine samples. Diagnostic accuracy of 94% achieved when examining five cells per patient's sample. It is a statistically significant improvement ($p < 0.05$) in diagnostic accuracy compared to the currently used clinical standard, cystoscopy, as verified on 43 control and 25 bladder cancer patients [4].

This method can also be applied for the detection of other cancers, in which cells or body fluid are available for analysis without the need for invasive biopsy, e.g., upper urinary tract, urethra, colorectal and other gastrointestinal, cervical and aerodigestive cancers. Furthermore, the described approach can be extended to detect cell abnormalities beyond cancer as well as to monitor cell reaction to various drugs (nanopharmacology).

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