How to Distinguish between Cancer and Normal Cells: a Physicist's View

Igor Sokolov (isokolov@clarkson.edu)
Swaminathan Iyer
Venkatesh Subba-Rao
Craig Woodworth
Clarkson University, Potsdam, NY 13699, USA

Author Summary of Paper V26.1
Thursday, March 16, 2006, 11:15 AM, Rm 323
2006 APS March Meeting, Baltimore, MD

Early detection of cancer can seriously ease if not eliminate the threat of this disease Even a single malignant cell can cause irreparable damage. This is why detection of cancer (and pre-cancer) cells is paramount. So far, the methods of detection have been based on traditional techniques used in biology, such as specific ligand-receptor interaction or DNA analysis. Despite being well developed, these methods have problems in "scaling up", thus keeping them from being sufficiently simple and broadly available to physicians. A search for alternative "physical" methods for detecting cancer cells may be a fruitful approach. Recent advances in physics instrumentation have provided new opportunities to study cancer cells. In particular, atomic force microscopy (AFM) can be used to study motion and mechanics of cancer cells. However, to date there are only anecdotal reports about studying the difference in mechanics of cancer and normal cells.

Here we present the first detailed study comparing the mechanics of cancer and normal cells of human cervix. We used well defined quantitative model, we use an AFM probe modified with microns size silica ball. We also investigated a statistically sound number of cells. We found that the difference in cell mechanics is more complicated than was previously known. Here we report the first evidence of a difference in the surface molecules on normal and cancer cells using AFM. This finding allowed us to develop two novel methods for detection cancer cells by using fluorescent silica particles which were developed by the Sokolov's group. (Such particles are not expensive and can be made available to any medical lab.) Both methods are based on the "physical" adsorption of silica particles onto the cells. Differences in the number of adsorbed particles (detected by simple optical methods) indicate if the cells are normal or cancerous. The methods have been tested using cell lines taken from three healthy individuals and three patients with cervical cancer. The methods have shown an ability to identify cancer cells unambiguously. Fig.1 demonstrates one of the methods. Each image shows single cells in the middle. One can clearly see the difference in affinity of the silica particles for cells: normal cells are virtually free of the particles (just surrounded by them here), while the cancer cell is almost completely covered by the particles.

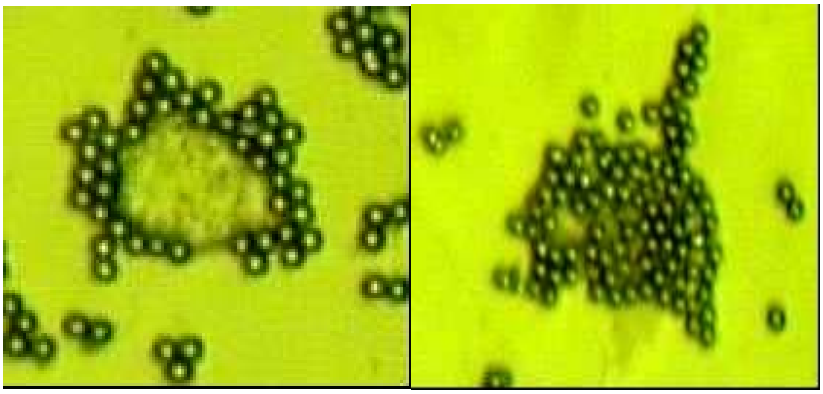

Figure 1. Optical images of single normal (left) and cancer (right) cervical cells showing different adhesion to 5 micron silica particles (small round balls).

Financial support by the Coulter Foundation and NSF (CCR-0304143) are acknowledged.