Direct Observation of Effects of Photodynamic Therapy using Atomic Force Microscopy

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Photodynamic Therapy (PDT) is a method in which a photosensitizer is administered in vivo and irradiated with light to generate reactive oxygen species (ROS), thereby causing the selective death of cancer cells. Since PDT is a non-invasive cancer treatment method with few adverse effects, it has attracted considerable attention and is increasingly used. However, the mechanism has not yet been clarified. ROS are signal-transduction materials which increase a production of cytoskeleton in a cell. Namely, influence of ROS on a cancer cell can be determined by the conditions of cellular membrane and cytoskeleton. Therefore, influence of ROS for the cancer cells are expected to be analyzed by observing the elastic modulus of cells. Here, we have directly observed the effects of PDT using atomic force microscopy (AFM) with the techniques to analyze the elastic modulus of the cell, which is the dominant effect of PDT.

Figure 1 shows a phase-contrast image and an elastic modulus mapping of cancer-like mutated rat gastric mucosal cell (RGK1) before and after PDT with porphylipoprotein (PLP), respectively. For light irradiation for 1 minute, variation of the elastic modulus around cell nuclei was slight. On the other hand, for light irradiation for 1 minute and incubation for 4 minutes at 37 ℃, the elastic modulus around cell nuclei was higher than before irradiation, the average of the elastic modulus increased from 3.5 kPa to 4.3 kPa. The results indicate that the produced ROS influenced to the production mechanism of cytoskeleton, and RGK1 necessary about 5 minutes to form cytoskeleton after ROS produce. Details will be discussed at the colloquium.

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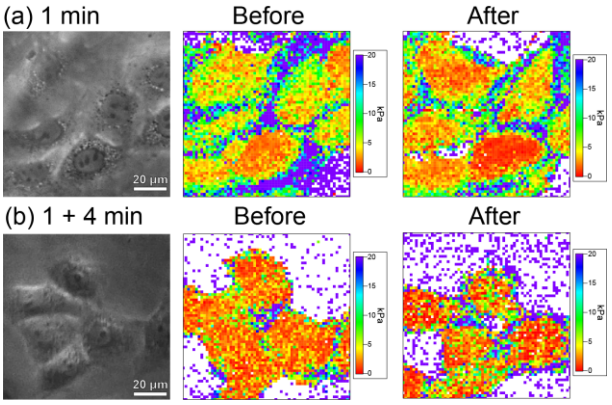

Fig. 1 Results obtained by irradiating RGK1 with light for 1 minute ((a)), and 1 minute and incubation for 4 minutes at 37 ℃ ((b)).

[1] T. Suzuki, et al. Cancers 12, 9 (2020).

[2] L. Cui, et al. ACS Nano 9, 4484 (2015).