The effect of a blood-flow shear stress on vascular endothelial cells may be a key to elucidating the mechanism of atherogenesis

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Born in 1949. Acquired a Ph.D. in the doctoral course, M. Sc. Mechanical Engineering, Graduate School of Engineering, Kyoto University, in 1976. Worked with Nikkiso Co., Ltd. Worked as a researcher at the Department of Mechanical Engineering, University of Houston. Assumed the position of Assistant Professor at University of Tsukuba. Has been Professor at the Faculty of Engineering, Tohoku University since 1992. Appointed as Professor at the Graduate School of Engineering, and then, as Associate Dean at the same Graduate School. Appointed as Visiting Professor at the Graduate School of Medicine, Dentistry and Pharmaceutical Sciences, Okayama University. Has been in his current position as the Dean of the Graduate School of Biomedical Engineering since 2008. Ph.D. in engineering. Served as the Leader of the 21st Century COE Program of Future Medical Engineering Based on Bio-Nanotechnology for 2002–2007.

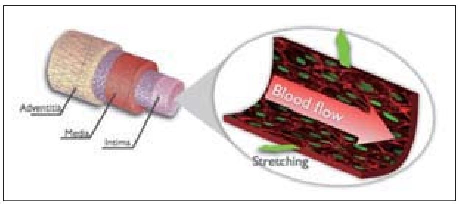
http://www.biomech.mech.tohoku.ac.jp/satolab/

Cutting-edge medical examination technology can hardly identify “what part of the artery has what degree of atherosclerosis.” Professor Masaaki Sato and his colleagues are now performing research that may elucidate the mechanism of atherosclerosis, with the possibility of greatly improving its treatment and examination methods.

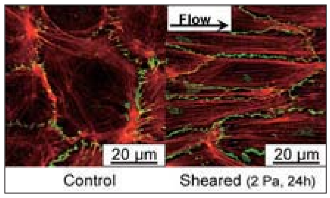
One of the research subjects on which Professor Sato, *et al.,* are working is the workings of endothelial cells that cover the internal walls of a blood vessel. These endothelial cells have a unique sensor that senses the force of flowing blood rubbing the vessel wall, i.e., shear stress. They vary in their form and functions according to the shear stress, which expands or shrinks the blood vessel, which in turn controls the blood flow and pressure. The mechanism by which this occurs is still a mystery. Professor Sato, *et al.,* are working on how endothelial cells change their shapes according to the magnitude of shear stress, where the sensor of these cells that sense the force is located in the cell, how that sensor functions, and on a quantitative basis to elucidate their working mechanism.

Actually, this deformation of endothelial cells is related to atherosclerosis. The theory is that endothelial cells normally cover the internal walls without gaps, but there can be gaps in regions where the shear stress is low because such cells bind to one another weakly there, and LDL enters into the gaps. If this mechanism is elucidated, it may lead to not only preventing and treating atherosclerosis but also the possibility of in-blood monitoring and the identification of parts with atherosclerosis. In addition, their research is also expected to make a return contribution to the field of engineering and also robotics.

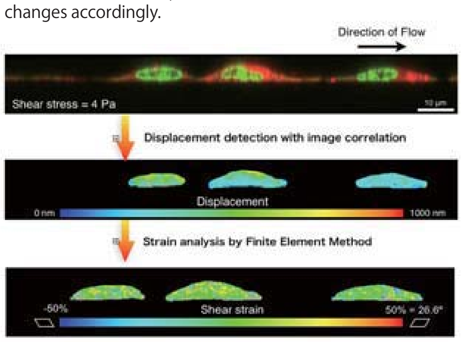
The subject of “the effect of a blood-flow shear stress on the shapes and functions of vascular endothelial cells” is being researched by Prof. Sato, Assistant Prof. Sakamoto, and two students in the doctoral course. They are engaged in a quantitative exploration of a world measurable in nanometers.



Endothelial cells that reside in the innermost layer of blood vessel walls are always exposed to forces (shear stress) due to the blood flow and the deformation of the walls.



When force is applied via flow to a cultured endothelial cell, the cell changes its shape from a polygon on the left figure to a spindle shape on the right figure to adapt to the dynamic environment. The cytoskeletal structure (red) inside it changes accordingly.



A lateral cross-section of an endothelial cell when subjected to flow, and the deformation inside. In the uppermost figure, green indicates the nucleus, and red cytoplasm. In the middle and lowermost figures, no boundaries of the nucleus are observed, which means that both the nucleus and cytoplasm are deformed almost to the same degree.

My favorite

Although Prof. Sato now uses a personal computer to create materials and papers, he still writes with a fountain pen in the process of organizing his thoughts. The first fountain pen he used was a Montblanc that he bought more than 30 years ago. His collection consists of about ten fountain pens contained in a dedicated case.