Computational Nanobiomechanics for the diagnosis, treatment, and prevention of diseases of blood, circulatory, and digestive organs

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【Outline of survey】

In this study, we aim at computational fluid dynamics studies on macroscale hemodynamics such as blood flow in the heart and large arteries, microscale blood flows in small vessels in which blood is assumed to be a suspension of red blood cells in plasma, and single red blood cell motions in an induced flow field. A living system, either as a whole or as a subsystem, such as human circulatory system, is always under the integrated nervous and humoral control of the whole body, i.e., in homeostasis. Multiple feedback mechanisms with mutual interactions among systems, organs, and even tissues provide integrated control of the entire body. These control mechanisms have different spatial coverage, from the micro- to macroscale, and different time constants, from nanoseconds to decades. Thus we need multi-scale computational analysis to understand macroscale as well as microscale blood flows in human circulatory system.

【Expected results】

Due to the rapid advances in invasive and noninvasive imaging technology in clinical medicine, it is now possible to obtain images of target organs for use in computational analysis modeling. Our ultimate goal is to build a system that can assist clinicians in diagnosis, treatment planning, and as patients differ in terms of anatomical configuration and disease condition, a wide variety of patient data must be accumulated, not only for statistical analysis but also to improve the processing system. This is part of a long-term research program in the field of computational medicine, which will inevitably become part of mainstream medical development in the near future. The introduction of computational mechanical assistance to medical diagnosis and treatment will enhance the objectiveness of medical decisions.

【References by the principal investigator】

・Yamaguchi T., Ishikawa T., Tsubota K., Imai Y., Nakamura M. and Fukui T., Computational Blood Flow Analysis —New Trends and Methods, J. Biomechanical Science and Engineering, 1(1), 29-50 (2006).

【Term of project】 FY2007− 2011	【Budget allocation】 26,700,000 yen (2007 direct cost)

【Homepage address】 http://www.pfsl.mech.tohoku.ac.jp/