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# Computational biomechanics for investigating various diseases over micro to macro scales

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## Summary

Human cardiovascular 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 coverages, from the micro- to macroscale, and different time constants, from nanoseconds to decades. We think that these variations in spatial as well as temporal scales should be taken into account in discussing phenomena in the cardiovascular system.

In this background, we have been investigating the cardiovascular system over micro to macro levels by using conjugated computational mechanics analyzing fluid, solid and bio-chemical mechanics. In the present study, we introduce our recent researches on a novel hemodynamic index for the initiation of cerebral aneurysms focusing on temporal variation of spatial wall shear stress gradient, the mass transport to saccular aneurysm, and primary thrombus formation.

Not only the cardiovascular system, we have also investigated air flow in the lung using a patient specific geometry. We applied adaptive mesh refinement method to efficiently calculate the pulmonary airflow. We introduce these works in this paper, too.

In the future analysis, biological phenomena need to be included in discussing physiological as well as pathological, i.e. disease processes. We expect this to be accomplished in the future by integrating new understandings of macroscale and microscale biomechanics, if we continue to be together with advances of related sciences and technologies.

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