11th. World Congress on Computational Mechanics (WCCM XI)
5th. European Conference on Computational Mechanics (ECCM V)
6th. European Conference on Computational Fluid Dynamics (ECFD VI)
July 20 - 25, 2014, Barcelona, Spain

Multiscale Simulations of the Primary Stage of Thrombus Formation

Kazuyasu Sugiyama[1], Satoshi Ii[2], Shu Takagi[3], Yoichiro Matsumoto[3]

[1]Advanced Center for Computing and Communication, RIKEN, 2-1 Hirosawa, Wako-shi, Saitama, Japan
kazuyasu.sugiyama@riken.jp
[2]Graduate School of Engrg. Sci, Osaka Univ., 1-3 Machikaneyama, Toyonaka-shi, Osaka, Japan
[3]School of Engrg., The Univ.. of Tokyo, 7-3-1 Hongo, Bunkyo-ku, Tokyo, Japan

Key Words: *Blood Flow, Fluid-Membrane Interaction, Ligand-Receptor Interaction, Thrombus Formation*

We have developed a multiscale simulator for the primary stage of thrombus formation as a result of a platelet adhesion to an injured vessel wall. To capture continuum scale blood flows including a large number of red blood cells (RBCs) and platelets, the simulator numerically solves fluid-structure/membrane interaction problems [1]–[3]. It also treats a molecular scale ligand-receptor interaction between the von Willebrand factor on the injured vessel wall and the GPIbα on the platelet by means of the stochastic Monte-Carlo method [4]. From the simulated results obtained using massively parallel computing, we discuss the effect of the RBC, which induces the fluctuating motion of the surrounding liquid and causes the dispersed motion of the platelet, on the enhancement of the thrombus formation in view of the particulate flow dynamics.

REFERENCES

[1] Ii, S., Gong, X., Sugiyama, K., Wu, J., Huang, H. and Takagi, S., A full Eulerian fluid-membrane coupling method with a smoothed volume-of-fluid approach, *Comm. Comput. Phys.*, Vol. 12, pp. 544–576, 2012.
[2] Ii, S., Sugiyama, K., Takagi, S. and Matsumoto, Y., A computational blood flow analysis in a capillary vessel including multiple red blood cells and platelets, *J. Biomech. Sci. Engrg.*, Vol. 7, pp. 72–83, 2012.
[3] Sugiyama, K., Kawashima, Y., Noda, S., Ii, S., Koyama, H., Takagi, S., Matsumoto, Y. and Himeno, R., Massively parallel computing of novel fluid-structure interaction solver on the K computer, *Proc. of Symp. on High Performance Computing and Computational Science 2013*, IPSJ-HPCS2013050, 2013.
[4] Shiozaki, S., Ishikawa, K.L. and Takagi, S., Numerical study on platelet adhesion to vessel walls using the kinetic Monte Carlo method, *J. Biomech. Sci. Engrg.*, Vol. 7, pp. 275–283, 2012.