OP03 18 Takashima, K (Advanced Science Institute, RIKEN, Japan) Core to core invited speaker

Computational simulation for catheter and guidewire motion in blood vessels

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Background and purpose: We have developed a system to simulate a catheter and guidewire in blood vessels for surgical planning, intra-operative assistance and the design of new catheters. In our previous study, we evaluated the effects of the parameters of the guidewire and the blood vessel on the simulation system using a torus-shaped vessel model. However, in clinical applications, numerical data should be acquired by image processing of data on the vasculature acquired from the patient. Therefore, in this study, we used patient-specific data and compared the simulation results with medical images for validation of the simulation system. **Methods**: The guidewire model is composed of viscoelastic springs and segments. The proximal part of the guidewire model is constrained by the catheter model, which is fixed and assumed to be a rigid tube. The blood vessel model is a circular elastic cylinder, whose shape is defined by the centerline and the radii. Collisions between the guidewire model and the blood vessel model are calculated and the contact forces are determined according to the stiffness of the vessel wall. In this study, the centerline of the blood vessel model and the actual positions of the guidewire were calculated by image processing of the section data of the vasculature acquired from the patient and were compared with simulation results. We used several types of image data with aneurysms growing near the arterial circle of Willis. **Results and Discussion**: As the proximal end of the guidewire model is pushed and pulled, the guidewire model approaches the actual guidewire position. In this study, we also calculated the geographical features of blood vessels in order to accurately evaluate the simulation results. In the future, we would like to construct a database of simulation data and to statistically analyze the relationships between aneurysms and various geometries.

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Computational simulation of flow at bleb of aneurysms

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Purpose: To visualise flow at parent arteries and aneurysms by computational fluid dynamics (CFD). By this visualisation, specific flow pattern at bleb was considered. Also, to visualise the finding by diagnostic catheter angiography.
Materials and Methods: Three dimensional (3D) structures of aneurysms were obtained by 3D DSA or 3D time of flight MR angiography. The 3D structure was given to our home brew voxcel based CFD system, which did not need manual segmentation nor mesh generation. The calculation model had solid wall, at present, and flow pattern was pulsatile, whose pattern was gotten by Dopper wire. The results were visualised by home brew visualisation application. The findings were tried to visualise by diagnostic angiography.
Results: To calculate at 128×128×128 voxcel model, it took about 7 or 10 days for 3 or 4 cycles using Xeon 5160 quad core system. For preparation, it took only a few hours as no need of mesh generation. Most of bleb had poor flow into themselves. Well-preparated high speed DSA could confirm slow flow at bleb by slow contrast filling.
Conclusion: CFD for aneurysm with bleb showed decreased flow at bleb. Relatively slow flow was thought to a possible risk factor of rupture, also low share probably.