E-008 VIRTUAL MICRO-CATHETER DELIVERY SIMULATION COMPARISON BETWEEN SIMULATION AND ACTUAL DELIVERY

[1]S Fujimura*, [2]H Takao, [1]Y Uchiyama, [1]H Ono, [1]T Ishii, [1]T Okudaira, [3]T Ishibashi, [4]K Otani, [5]K Fukudome, [5]M Yamamoto, [3]Y Murayama. [1]*Graduate School of Mechanical Engineering, Tokyo University of Science, Tokyo, Japan*; [2]*Department of Innovation for Medical Information Technology, Jikei University School of Medicine, Tokyo, Japan*; [3]*Department of Neurosurgery, Jikei University School of Medicine, Tokyo, Japan*; [4]*Siemens Healthcare K.K., Tokyo, Japan*; [5]*Department of Mechanical Engineering, Tokyo University of Science, Tokyo, Japan*

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Introduction To ensure safe and stable coil embolization for intracranial aneurysms, shaping the tip of the micro-catheter to be used is one of the most important factors. Therefore, if it was possible to simulate the micro-catheter delivery before procedure, we could understand where the micro-catheter tip would settle and whether the shaped geometry is optimized or not. We developed a virtual micro-catheter delivery simulation using the numerical simulation technique of finite element method (FEM). We validated the virtual micro-catheter delivery simulation by comparing the simulated results and an actual delivered micro-catheter path line.

Materials and methods We selected one middle sized internal carotid (ICA) artery aneurysm, which had performed successful coil embolization by a neurosurgeon (board certified, 15 years of experience). The 3D geometrical data of the artery and aneurysm before surgery were reconstructed from digital subtraction angiography data. The generated region ranged from the ICA cervical part to the bifurcation point of the middle cerebral (MCA) and anterior cerebral arteries (ACA). FEM was applied to simulate the virtual micro-catheter delivery. The virtual catheter was modeled using elastic Timoshenko beam elements and was inserted from the ICA under stress free condition at a speed of 10 mm/s. After the tip of the catheter was settled at the aneurysm, we exported the 2D images of the virtual catheter and artery from two different angles that were the same as the actual 2D angiographic images during embolization. We qualitatively and quantitatively compare the micro-catheter path line of the catheter by overlapping the simulated image and actual image.

Results The path lines of the simulated and actual catheters corresponded well to each other on the images from both angle (see the attached figure 1). To evaluate the results quantitatively, we calculated the area under the catheter path line curves from the simulation and actual delivery. On the images of both angles, the relative errors of the area were around 10%. Although the simulation had limitations including rigid artery and non-blood flow in the artery, we were able to obtain a validated catheter path line using our virtual micro-catheter delivery simulation.

Conclusions The simulated path line of the inserted virtual micro catheter showed good correlation with the actual catheter path line. This simulation may be applicable to optimize the shape of the micro catheter to ensure stable delivery during coil embolization.

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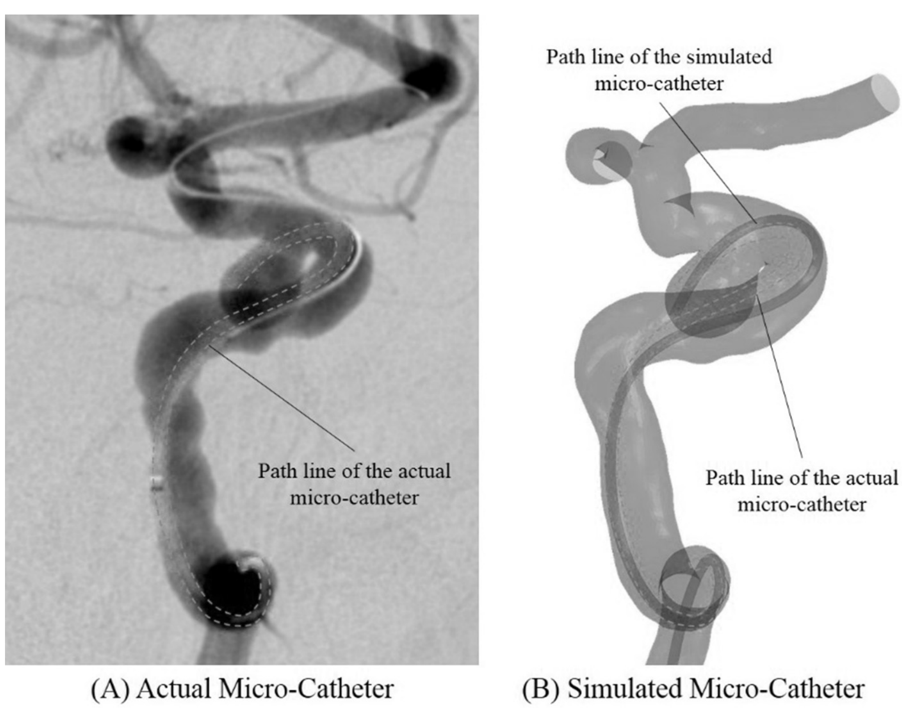

Abstract E-008 Figure 1