Development and commercialization of patient-specific high-precision robotic surgical simulator

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We developed a technology for precisely constructing a three-dimensional model of patient's organ structure, especially vascular structure (Fig. 1) from CT / MRI information. We further developed a humanoid robot for catheter surgery simulation shown in figure 2 and figure 3 by adding functions and humanoid body to this three dimensional model brought by this technology. Now, we are providing these three-dimensional organ models and humanoid robot as a surgical simulator for (1) surgery rehearsal, (2) technical training and (3) evaluation of medical equipments.

The first technical aspect of our invention is the following patient-specific organ modeling process. (1) Three-dimensional shape of a organ of interest is reconstructed from CT / MRI information. (2) Lost-wax molds are constructed from this data using 3D printer. (3) Organ model, especially vascular model, is finally constructed using these lost-wax molds. This manufacturing process is compatible with various materials such as silicone rubber (Fig. 1), plastics, hydro-gels, and biocompatible materials for regenerative medicine (e.g. PLA). Modeling accuracy is more than 20 □m and so minute organ structure required to surgical simulation is reproducible. Since modeling can be completed in several hours (depends on applied material), this process is adequate for organ models for surgery rehearsal and other urgent use. With these superior characteristics, this organ model have been introduced into hospitals and R&D organizations worldwide, playing an active part in various purpose. Today, we are preparing mass-production.

The second technical aspect of our invention is the humanoid robot for endovascular surgery simulation, "EVE (Endovascular Evaluator)" (Fig. 2). EVE is a whole body robotic surgical simulator equipped with measurement function and physiological function (e.g. pulsate blood circulation) on the three-dimensional vascular models in order to evaluate medical skills and the medical equipment performance quantitatively in realistic way. Added function includes (1) 3-dimensional photoelastic stress measurement, (2) virtual fluoroscopy, (3) visual interface with real-time numerical information, graphs and videos, (4) pulsatile blood circulation with realistic pressure and flow rate. Today, EVE is active in hospitals and major medical equipment manufacturers as a cutting edge simulator.

We founded a university-based venture company "FAIN-Biomedical Inc." with this technology in 2005. These organ models and humanoid robot have been introduced to hospitals and medical equipment manufacturers worldwide, contributing to the development and dissemination of simulator-based surgical training course and medical equipment evaluation. (The Japanese Society for Neuroendovascular therapy (JSNET) introduced the vascular model into their Licensing examination and it dramatically enhanced awareness of the importance of medical simulation).

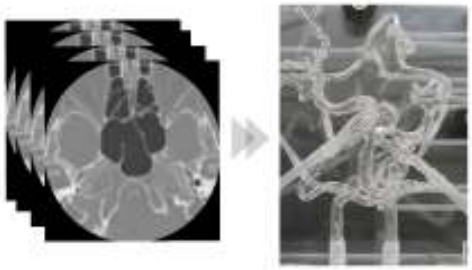

Figure 1 Patient-specific high-precision vascular model for surgical simulation

Figure 2 Patient-specific high-precision robotic surgical simulator, "EVE"

Figure 3 Surgical skill training with EV