Surgery simulator for brain thrills neurosurgeons

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In recently completed practical tests at the Department of Neurosurgery at Kepler University Hospital, Linz (Austria), a highly advanced brain surgery simulator has received overwhelming approval from experienced neurosurgeons. In a unique first, the system is able to simulate complicated surgery for dangerous bulges in arteries under realistic conditions. This could offer major benefits in training neurosurgeons to perform these challenging operations. The results have been published in the international journal *World Neurosurgery*.

It's not just pilots who need to ensure that the tools of their trade provide pinpoint precision. In neurosurgery, precision is just as much a matter of life and death. In both cases, training the necessary skills should be absolutely risk-free. Responding to these demands, the Department of Neurosurgery at Kepler University Hospital in Linz developed a high-performance simulator for budding neurosurgeons, which has now been put through expert testing.

Innovation with feeling

The development of the highly promising simulator involved neuroscientists and software engineers engaging in close collaboration. According to Prof. Andreas Gruber, Chairman of the Department of Neurosurgery, "This collaboration has, for the first time ever, enabled us to simulate arterial wall movement and real blood flow with a very high degree of realism. These two factors are crucial for successfully treating

dangerous bulges in arteries known as aneurysms. While correct placement of the clips used to fix aneurysms is highly dependent on arterial wall movement, changes in blood flow are a crucial source of information about the success of the operation."

But the simulator developed at Kepler University Hospital pushes the innovation envelope even further. Trainees are able to use the actual instruments involved in these operations, allowing a greater degree of realism than ever before. And that's still not all – the simulator even features real-time technology. This means that the encounter between surgical instrument and arterial wall is computed instantly, with no lag, thereby matching the chronology of a real operation. "In this way, surgeons can learn under realistic conditions," notes Prof. Gruber, "This is absolutely essential for training and perfecting key skills, such as hand-eye coordination, depth perception and tactile discrimination."

Practical evaluation

The simulator has now been tested by experienced neurosurgeons with an average of over 14 years of neurosurgery experience. The simulations were based on data from actual operations. This allowed the results of the simulated surgery to be compared with the results of actual surgery. After using the simulator, 89% of the neurosurgeons reported that it had improved their anatomical understanding, while as many as 94% would like to see the simulator incorporated into neurosurgery education.

The software system for virtual aneurysm surgery has been under development since 2012 in a joint project between the Department of Neurosurgery and the Institute for Neuroradiology at Kepler University Hospital, in cooperation with RISC Software GmbH, Hagenberg (Austria). The challenge has been to achieve the greatest possible degree of realism while minimising the required computing power. On the one hand, the simulation requires a demanding mathematical model to

represent arterial wall behaviour. On the other hand, the realistic simulation of the operation calls for real-time computations. By drawing on special methods and algorithms and thanks to smart allocation of available processing power, the team has succeeded in meeting the different requirements.

Groundbreaking simulation

The paper, which has been published in an international journal, once again demonstrates the importance that Austria's largest University Hospital Neurosurgery Department places on integrating tried and tested innovation into its clinical practice. The ultimate goal is that simulations of aneurysm surgery should be used for both education and training, as well as for pre-operative planning.

More information: Matthias Gmeiner et al. Virtual Cerebral Aneurysm Clipping with Real-Time Haptic Force Feedback in Neurosurgical Education, *World Neurosurgery* (2018). DOI: 10.1016/j.wneu.2018.01.042

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