Virtual reality simulator for aneurysmal clipping surgery

Alaraj et al., developed a real-time sensory haptic feedback virtual reality aneurysm clipping simulator using the ImmersiveTouch platform. A prototype middle cerebral artery aneurysm simulation was created from a computed tomographic angiogram. Aneurysm and vessel volume deformation and haptic feedback are provided in a 3-dimensional immersive virtual reality environment. Intraoperative aneurysm rupture was also simulated. Seventeen neurosurgery residents from 3 residency programs tested the simulator and provided feedback on its usefulness and resemblance to real aneurysm clipping surgery.

Residents thought that the simulation would be useful in preparing for real-life surgery. About two-thirds of the residents thought that the 3-dimensional immersive anatomic details provided a close resemblance to real operative anatomy and accurate guidance for deciding surgical approaches. They thought the simulation was useful for preoperative surgical rehearsal and neurosurgical training. A third of the residents thought that the technology in its current form provided realistic haptic feedback for aneurysm surgery.

Neurosurgical residents thought that the novel immersive VR simulator is helpful in their training, especially because they do not get a chance to perform aneurysm clippings until late in their residency programs [1)].

Brain deformation is one of the most important functionalities necessary for an accurate clipping simulator and is vastly affected by the status of the supporting tissue, such as the arachnoid membrane. However, no virtual reality simulator implementing the supporting tissue of the brain has yet been developed.

Three-dimensional computer graphics models of cerebral tissue and surrounding structures were extracted from medical images. We developed a new method for modifiable cerebral tissue complex deformation by incorporating a nonmedical image-derived virtual arachnoid/trabecula in a process called multitissue integrated interactive deformation (MTIID). MTIID made it possible for cerebral tissue complexes to selectively deform at the site of dissection. Simulations for 8 cases of actual clipping surgery were performed before surgery and evaluated for their usefulness in surgical approach planning.

Preoperatively, each operative field was precisely reproduced and visualized with the virtual brain retraction defined by users. The clear visualization of the optimal approach to treating the aneurysm via an appropriate arachnoid incision was possible with MTIID.

A virtual clipping simulator mainly focusing on supporting tissues and less on physical properties seemed to be useful in the surgical simulation of cerebral aneurysm clipping. To our knowledge, this article is the first to report brain deformation based on supporting tissues [2)].

Video

<html><iframe width="560" height="315" src="https://www.youtube.com/embed/-KK28OvHmTE" frameborder="0" allowfullscreen></iframe></html>

1)

Alaraj A, Luciano CJ, Bailey DP, Elsenousi A, Roitberg BZ, Bernardo A, Banerjee PP, Charbel FT. Virtual reality cerebral aneurysm clipping simulation with real-time haptic feedback. Neurosurgery. 2015 Mar;11 Suppl 2:52-8. doi: 10.1227/NEU.0000000000000583. PubMed PMID: 25599200; PubMed Central PMCID: PMC4340784.

2)

Shono N, Kin T, Nomura S, Miyawaki S, Saito T, Imai H, Nakatomi H, Oyama H, Saito N. Microsurgery Simulator of Cerebral Aneurysm Clipping with Interactive Cerebral Deformation Featuring a Virtual Arachnoid. Oper Neurosurg (Hagerstown). 2017 Aug 1. doi: 10.1093/ons/opx155. [Epub ahead of print] PubMed PMID: 28973685.