Medical Xpress

3-D printing and Hollywood special FX bring heightened reality to surgical training

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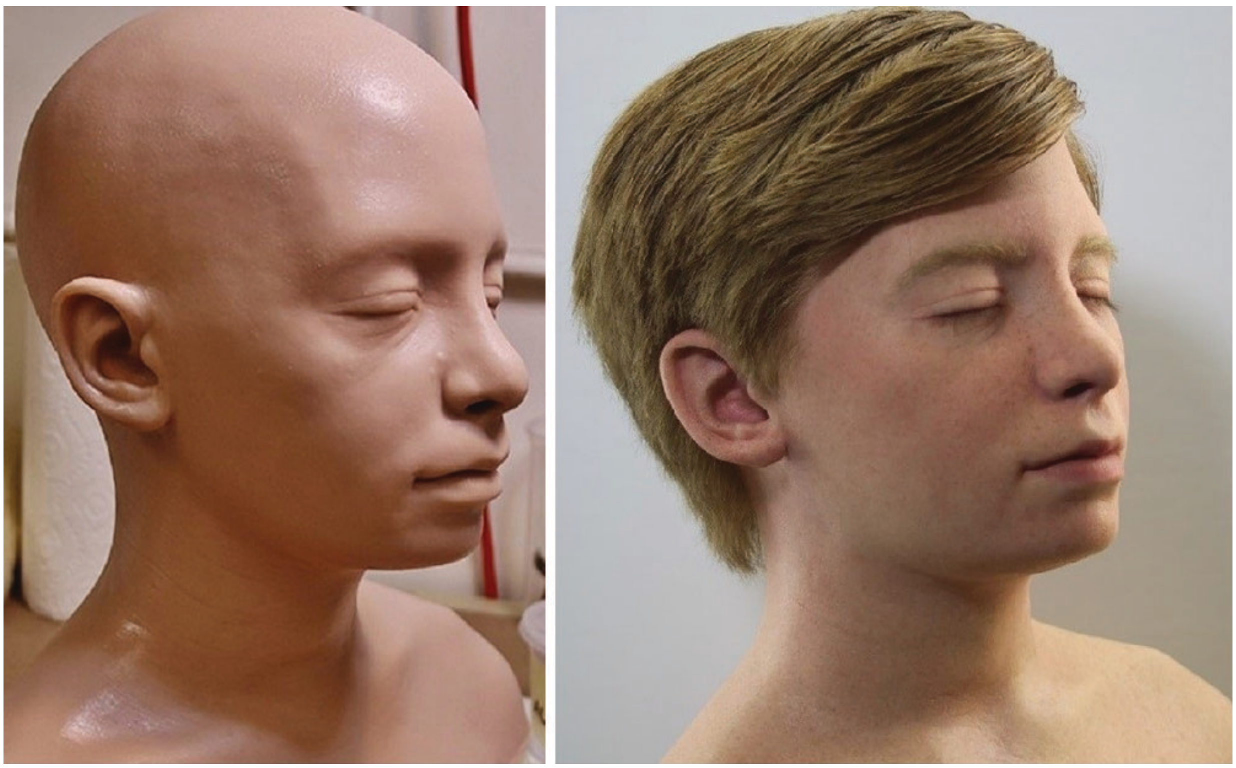

Note the realistic human-like features, including hair, eyelashes, and eyebrows. Credit: Copyright 2017 AANS.

A collaborative team of neurosurgeons, neuroradiologists, simulation engineers, and special effects experts have developed a unique tool to teach neurosurgical trainees how to perform minimally invasive surgical procedures. Using 3D printing and Hollywood-style special effects, the team constructed a training simulation model whose physical and functional qualities closely mimic those of the head and brain structures of an adolescent human patient.

A full description of this training model and its effectiveness can be found in a new article in the *Journal of Neurosurgery: Pediatrics*: "Creation of a novel simulator for minimally invasive neurosurgery: fusion of 3D printing and special effects," by Peter Weinstock, MD, PhD, and colleagues at Boston Children's Hospital and elsewhere.

A neurosurgery residency training program generally lasts seven years—longer than any other medical specialty. Trainees log countless hours observing surgeries performed by experienced neurosurgeons and developing operative skills in practice labs before touching patients. It is challenging to create a realistic surgical experience outside an operating room. Cadaveric specimens and virtual reality programs have been used, but they are costly and do not provide as realistic an experience as desired.

The new training simulation model described in this paper is a full-scale reproduction of the head of an adolescent patient with hydrocephalus. The external appearance of the head is uncannily accurate, as is the internal neuroanatomy.

One failing of 3D models is the stiffness of most sculpting material. This problem was overcome by addition of special-effects materials that reproduce the textures of external skin and internal brain structures. In addition, the operative environment in this training model is amazingly alive, with pulsations of a simulated basilar artery and ventricles as well as movement of cerebrospinal fluid. These advances provide visual and tactile feedback to the trainee that closely resembles that of the surgical experience.

The procedure selected to test the new training model was endoscopic third ventriculostomy (ETV), a minimally invasive surgical procedure increasingly used to treat hydrocephalus. The goal of ETV is to create a hole in the floor of the third ventricle. This provides a new pathway by which excess cerebrospinal fluid can circulate.

During ETV, the surgeon drills a small hole in the skull of the patient and inserts an endoscope into the ventricular system. The endoscope accommodates a lighted miniature video camera to visualize the operative site and specialized surgical instruments suited to perform operative tasks through the endoscope. The video camera sends a direct feed to external monitors in the operating room so that surgeons can clearly see what they are doing.

To evaluate the usefulness of the training simulation model of ETV, the researchers solicited feedback from users (neurosurgical residents and fellows) and their teachers. Trainees were asked to respond to a 14-item questionnaire focused on the external and internal appearances of the model and its tactile feel during simulated surgery (face validity) as well as on how closely the simulated procedure reproduced an actual ETV (content validity). The usefulness of the model in assessing trainees' performances was then evaluated by two attending neurosurgeons blinded to the identity and training status (post-graduate year of training) of the residents and fellows (construct validity).

The neurosurgical residents and fellows gave high scores to the training model for both face and content validity (mean scores of 4.69 and 4.88, respectively; 5 would be a perfect score). The performance scores given to individual trainees by the attending neurosurgeons clearly distinguished novice surgeons from more experienced surgeons, accurately reflecting the trainees' post-graduate years of training.

The training model described in this paper is not limited to hydrocephalus or treatment with ETV. The simulated head accommodates replaceable plug-and-play components to provide a fresh operative field for each training session. A variety of diseased or injured brain scenarios could be tested using different plug-and-play components. In addition, the ability to pop in new components between practice sessions greatly reduces training costs compared to other models.

When asked about the paper, the senior author, Alan R. Cohen, MD, at Johns Hopkins Hospital, said, "This unique collaboration of interdisciplinary experts resulted in the creation of an ultra-realistic 3D surgical training model. Simulation has become increasingly important for training in minimally invasive neurosurgery. It also has the potential to revolutionize training for all surgical procedures.

Provided in the article is a link to a brief video demonstrating the surgeon's view during a simulated ETV procedure.

More information: *Journal of Neurosurgery: Pediatrics* (2017). DOI: 10.3171/2017.1.PEDS16568

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