Universität Basel
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Development of a Modular 3D Printed Endoscopic Third Ventriculostomy Training Model

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The integration of digital technology in healthcare has led to improved patient care, streamlined operations, and increased efficiency. Although virtual reality and simulation technologies are increasingly being utilized in the healthcare sector, the training for surgical procedures is still predominantly reliant on conventional methods and observation-based learning. As the healthcare industry continues to evolve and adopt new technologies, it is essential to ensure that surgical training programs keep pace with these advancements.

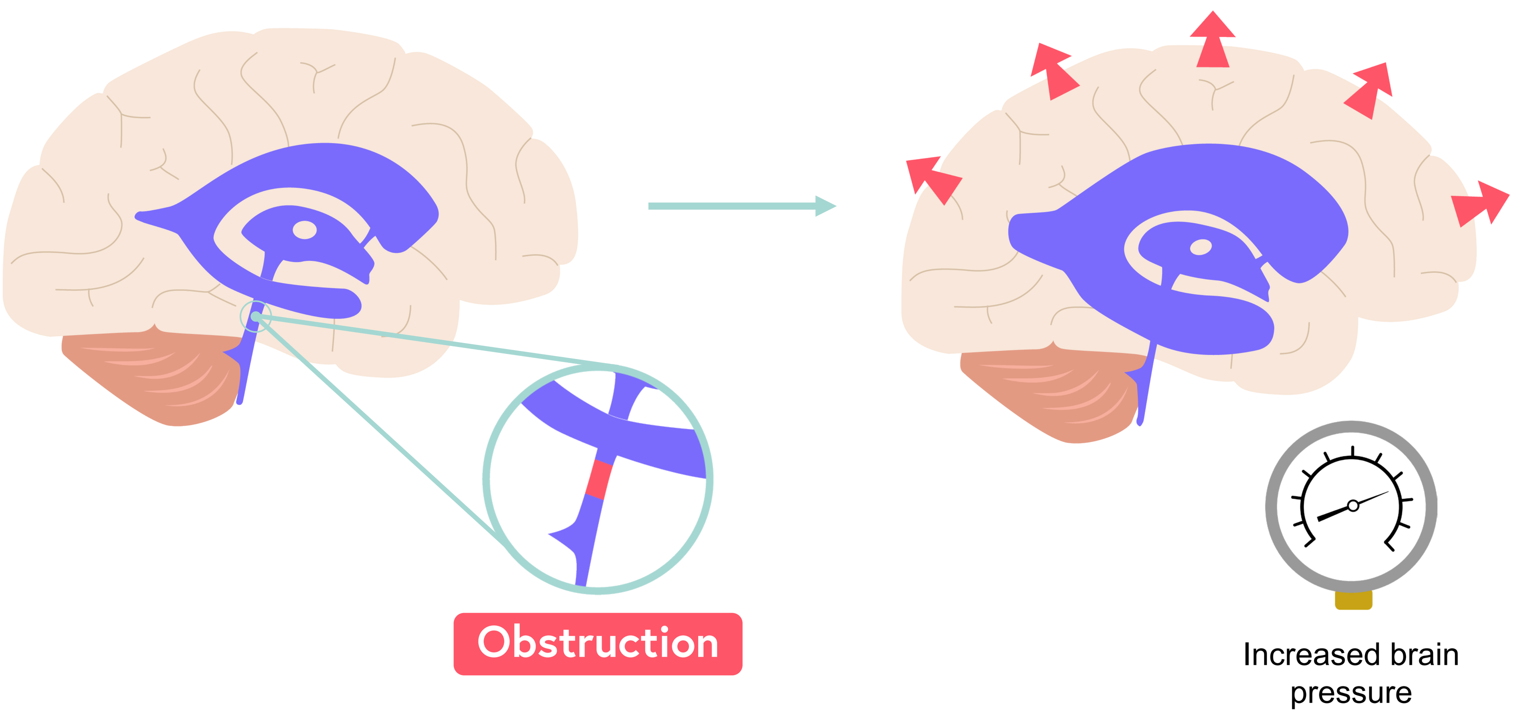


Figure 1. Increase in the size of the ventricles resulting from the accumulation of cerebrospinal fluid (CSF) subsequent to the occlusion of the cerebral aqueduct.

Surgical treatment of hydrocephalus is one of the interventions where the skill level of the surgeon is critical for the success of the procedure. This condition where excessive cerebrospinal fluid (CSF) accumulates in the brain's ventricles due to obstruction of the cerebral aqueduct, can be fatal if left untreated. Endoscopic third ventriculostomy (ETV) is a minimally invasive surgery that releases excess CSF and is the preferred treatment. However, traditional training methods involving cadavers are suboptimal due to ethical concerns and limited availability. Virtual reality (VR) devices have been developed as an alternative but lack haptic feedback and realistic surgical tools.

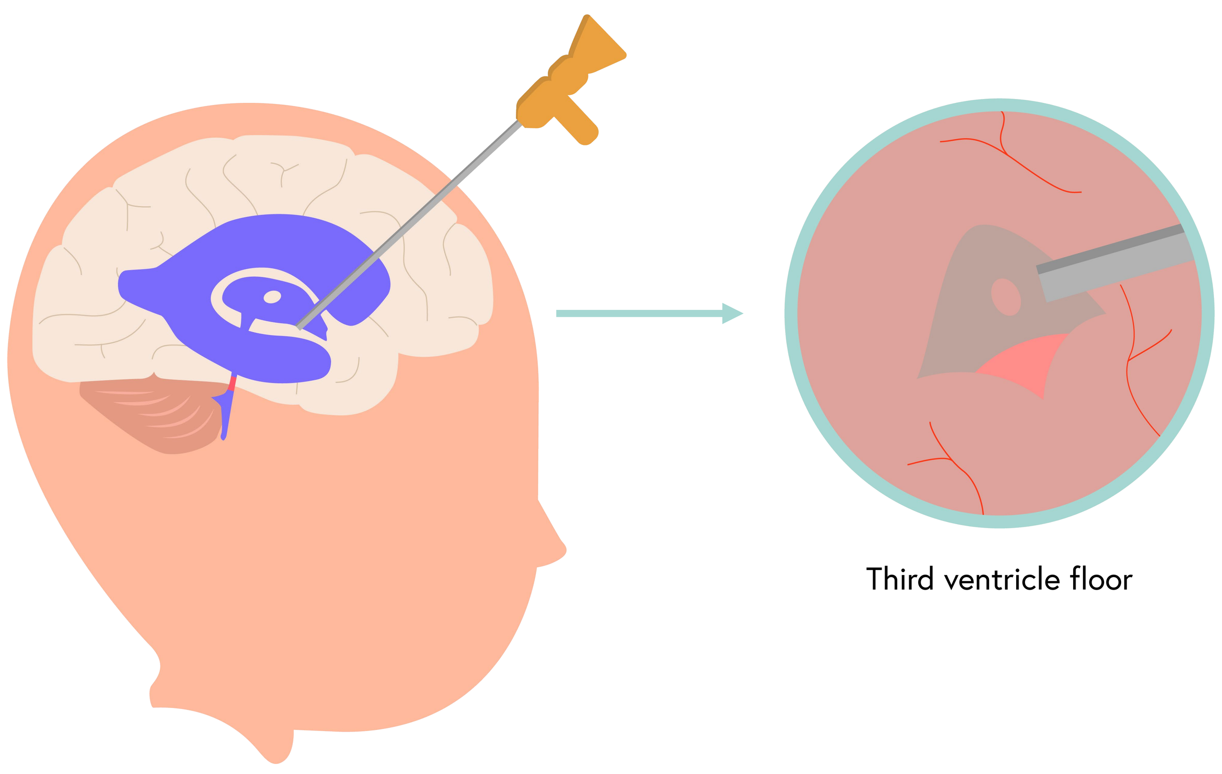
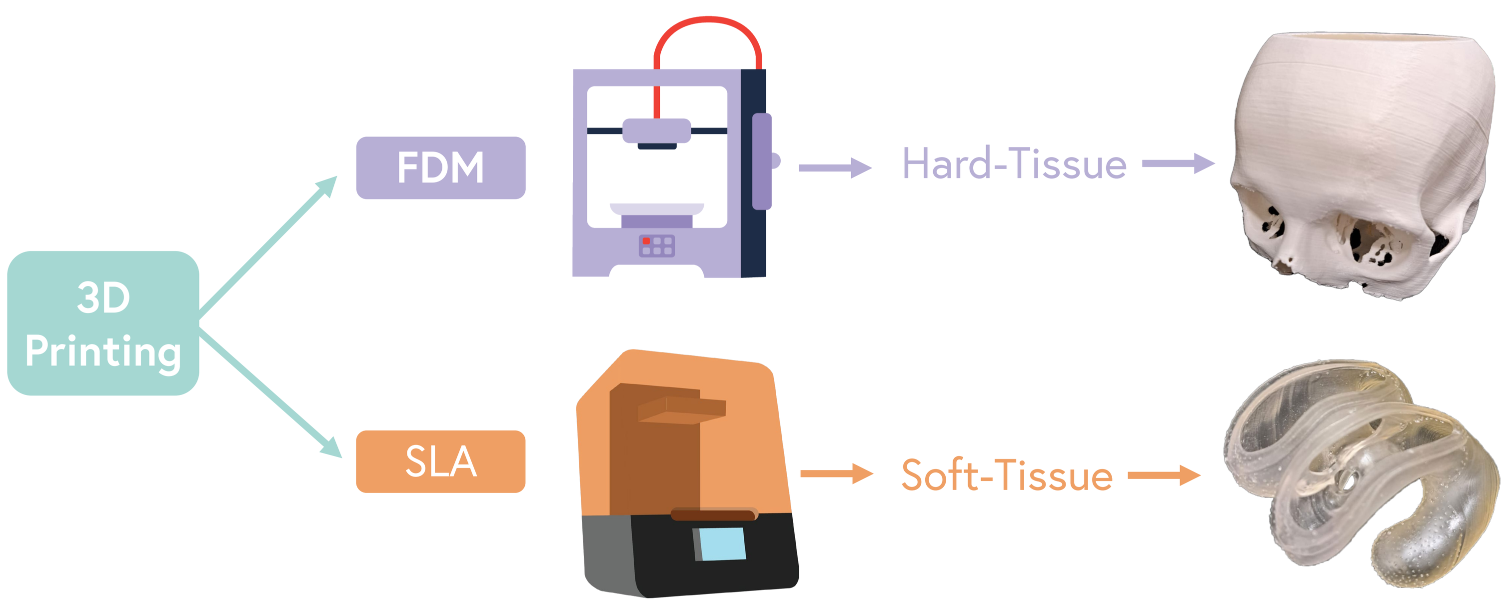


Figure 2. Third ventricle floor perforation utilizing an endoscope within the context of an endoscopic third ventriculostomy intervention for cerebrospinal fluid (CSF) evacuation and alleviation of intracranial pressure.

To overcome these limitations, this study presented a novel approach to ETV training using 3D-printed, patient-specific models. Using the patient's CT scan and MRI data, the main anatomical regions involved in the procedure were segmented and modelled by computer-aided engineering (CAE) software. Different materials and additive manufacturing technologies were used to print the models, simulating both hard and soft tissues. A modular assembly was implemented to facilitate the replacement of damaged components after every training allowing for repeatability. The in-house manufacturing of all components at the point of care promoted a fast and cost-efficient workflow.



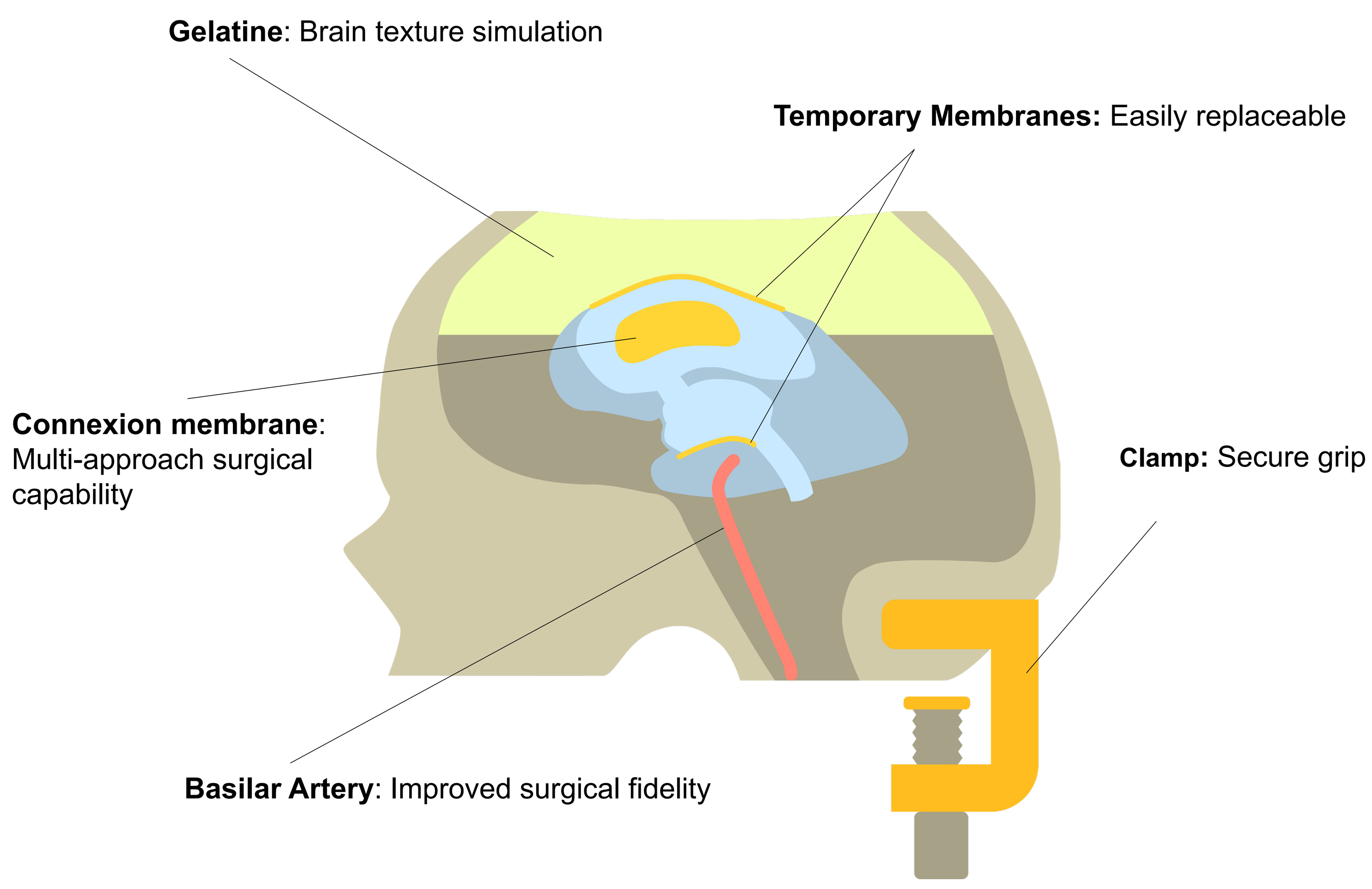


Figure 3. Modular 3D model for Endoscopic Third Ventriculostomy training.

In conclusion, this study introduced a novel approach to train medical students in ETV surgery using 3D-printed, patient-specific models. This approach addressed the challenges of cadaver-based and VR-based training, offering a valuable tool for improving surgical proficiency and patient outcomes in the treatment of hydrocephalus.

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