Ventricular catheter placement training

- Augmented reality for external ventricular drain placement: Model alignment and integration software
- Development and Validation of a Neurosurgical Phantom for Simulating External Ventricular Drain Placement
- Efficacy and Safety of Guideless Catheter Placement Technique in Revision External Ventricular Drainage and Ventricular Shunt Surgery
- In Vivo Testing of a Second-Generation Prototype Accessory for Single Transapical Left Ventricular Assist Device Implantation
- Clinical Characteristics and Outcomes of Patients Suffering Acute Decompensated Heart Failure Complicated by Cardiogenic Shock
- Augmented Reality-Based Contextual Guidance Through Surgical Tool Tracking in Neurosurgery
- Smart haptic gloves for virtual reality surgery simulation: a pilot study on external ventricular drain training
- Accuracy of routine external ventricular drain placement following a mixed reality-guided twist-drill craniostomy

Ventricular catheter placement (e.g., external ventricular drain or EVD) is a critical neurosurgical skill, especially for managing hydrocephalus, traumatic brain injury, or intracranial hypertension. Training for this procedure should balance anatomical knowledge, technical skills, and complication management.

 Key Objectives in Ventricular Catheter Placement Training Anatomical mastery

Landmarks: Kocher’s point (11 cm posterior to the nasion, 2–3 cm lateral to midline)

Trajectory: Aimed toward the ipsilateral medial canthus and external auditory meatus (or tragus)

Ventricular system anatomy (especially lateral ventricles, foramen of Monro)

Step-by-step technique

Position patient supine with slight head elevation

Identify Kocher’s point and mark entry

Perform sterile prep and local anesthesia

Make a small scalp incision

Create burr hole with a perforator or drill

Open dura and pass the catheter perpendicularly (~5–6 cm depth)

Confirm CSF flow, secure catheter, and connect to drainage system

Simulation training

Use of 3D-printed models, augmented reality, or virtual reality for practice

Cadaveric dissection for advanced skill refinement

Navigation systems or ultrasound-guided placement in difficult cases

Complication management

Misplacement (e.g., parenchymal, cisternal)

Hemorrhage (especially during reinsertion)

Infection (EVD-related meningitis)

Occlusion and troubleshooting flow issues

Documentation and outcomes

Record trajectory, CSF characteristics, ICP if monitored

Post-procedure CT to confirm placement

 Training Tools and Resources Simulators:

Simulab’s EVD trainer or similar phantom head models

NeuroTouch for virtual simulation

Videos and tutorials:

The Neurosurgical Atlas (by Dr. Aaron Cohen-Gadol)

YouTube neurosurgical channels (e.g., USC Neurosurgery or AANS educational series)

Checklists & evaluation tools:

OSATS (Objective Structured Assessment of Technical Skills) scoring system

Peer-reviewed simulation-based curricula

 Tips for Residents Always rehearse the trajectory mentally before inserting

Aim for controlled, smooth passage — never force the catheter

Use a catheter stylet if the ventricle is slit-like

Be ready to troubleshoot with irrigation or repositioning

Always confirm placement on CT scan if in doubt

Scheidt et al.'s publication presents a sophisticated training phantom designed for the simulation of external ventricular drainage (EVD), a core neurosurgical procedure. Developed collaboratively by clinicians and engineers at the University Hospital of Leipzig, the model aims to bridge the gap between theoretical knowledge and hands-on skill acquisition [1].

The phantom replicates the human skull and ventricular anatomy through three core elements: a 3D-printed skull model using polyamide (PA12), a ventricular system printed in flexible Elastic Resin 50A, and brain tissue simulation using cast gelatin. The use of 3D printing allows for high anatomical fidelity, and the model realistically simulates the sensation of trephination and cerebrospinal fluid (CSF) dynamics.

One of the strengths of this model is its modular and reproducible design, which enables iterative improvements and adaptation to different teaching environments. The authors report successful simulation of CSF flow and adequate material performance during cannulation and drilling exercises. The realistic mechanical properties of gelatin at 30g/L as brain tissue mimics are particularly promising for novice training.

However, the study has some limitations. The evaluation was restricted to a subjective Likert-scale assessment by a limited number of neurosurgeons. Quantitative validation of procedural accuracy, skill acquisition, and comparative outcomes against existing EVD training tools is necessary for broader adoption. Moreover, the need for additional material to accommodate chip formation during drilling suggests further optimization is required.

In conclusion, this model represents a substantial step forward in neurosurgical simulation and training. It offers a cost-effective, reproducible, and anatomically faithful alternative to cadaver-based training. Further studies are warranted to quantify its educational impact and improve its technical design. This work aligns well with modern pedagogical shifts toward hands-on learning and low-risk surgical practice environments.

3D-printing external_ventricular_drain neurosurgery simulation_model phantom medical_education surgical_training Leipzig

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A study was conducted to investigate a novel realistic design for a clinical simulation-based, low-cost alternative of external ventricular drain (EVD) placement, an essential basic neurosurgical procedure that is necessary for clinicians to master. A low-cost three-dimensional (3D) printed head using thermoplastic polylactic acid was designed with the tactile feedback of the outer table, cancellous bone, and inner tables for drilling with replaceable frontal bone pieces for multi-use purposes. An agar gel filled with water was designed to simulate tactile passage through the cortex and into the ventricles. Neurosurgical and emergency resident physicians participated in a didactic session and then attempted placement of an EVD using the model to gauge the simulated model for accuracy and realism. Positioning, procedural time, and realism were evaluated. Improvements in procedural time and positioning were identified for both neurosurgical and emergency medicine (EM) residents. Catheter placement was within the ideal position for all participants by the third attempt. All residents stated they felt more comfortable with placement with subsequent attempts. Neurosurgical residents subjectively noted similarities in tactile feedback during drilling compared to in-vivo. A low-cost realistic 3D printed model simulating basic neurosurgical procedures demonstrated improved procedural times and precision with neurosurgical and EM residents. Further, similarities between in-vivo tactile feedback and the low-cost simulation technology were noted. This low cost-model may be used as an adjunct for teaching to promote early procedural competency in neurosurgical techniques to promote learning without predisposition to patient morbidity [2)].

1)

Scheidt K, Kropla F, Winkler D, Möbius R, Vychopen M, Wach J, Güresir E, Grunert R. 3D-printed skull model for enhancing training in external ventricular drainage within medical education. 3D Print Med. 2025 Apr 3;11(1):16. doi: 10.1186/s41205-025-00263-0. PMID: 40178708.

[2)]

Podkovik S, Patchana T, Farr S, Brazdzionis J, Marino M, Savla P, Kashyap S, Chin B, Crouch A, Miulli DE. External Ventricular Drain (EVD) Placement Using a Hands-On Training Session on a Simple Three-Dimensional (3D) Model. Cureus. 2022 Aug 14;14(8):e28014. doi: 10.7759/cureus.28014. PMID: 36134074; PMCID: PMC9470865.