Title:	Neurosurgical Endoscopic Training via a Realistic 3-Dimensional Model With Pathology
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Abstract:	Introduction: Training in intraventricular endoscopy is particularly challenging because the volume of cases is relatively small and the techniques involved are unlike those usually used in conventional neurosurgery. Present training models are inadequate for various reasons. Using 3-dimensional (3D) printing techniques, models with pathology can be created using actual patient's imaging data. This technical article introduces a new training model based on a patient with hydrocephalus secondary to a pineal tumour, enabling the models to be used to simulate third ventriculostomies and pineal biopsies. Methods: Multiple models of the head of a patient with hydrocephalus were created using 3D rapid prototyping technique. These models were modified to allow for a fluid-filled ventricular system under appropriate tension. The models were qualitatively assessed in the various steps involved in an endoscopic third ventriculostomy and intraventricular biopsy procedure, initially by 3 independent neurosurgeons and subsequently by 12

	participants of an intraventricular endoscopy workshop. Results: All 3 surgeons agreed on the ease and usefulness of these models in the teaching of endoscopic third ventriculostomy, performing endoscopic biopsies, and the integration of navigation to ventriculoscopy. Their overall score for the ventricular model realism was above average. The 12 participants of the intraventricular endoscopy workshop averaged between a score of 4.0 to 4.6 of 5 for every individual step of the procedure. Discussion: Neurosurgical endoscopic training currently is a long process of stepwise training. These 3D printed models provide a realistic simulation environment for a neuroendoscopy procedure that allows safe and effective teaching of navigation and endoscopy in a standardized and repetitive fashion.
Keyword:	neurosurgical endoscopy; endoscopic third ventriculostomy; biopsy; simulation; training; 3d rapid prototyping; rapid prototyping techniques; laboratory model; technical note; simulation; surgery
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