Simulation of Ventriculostomy Placement Utilizing a Novel Fresh Tissue Cadaveric Cerebrospinal Fluid Perfusion Model

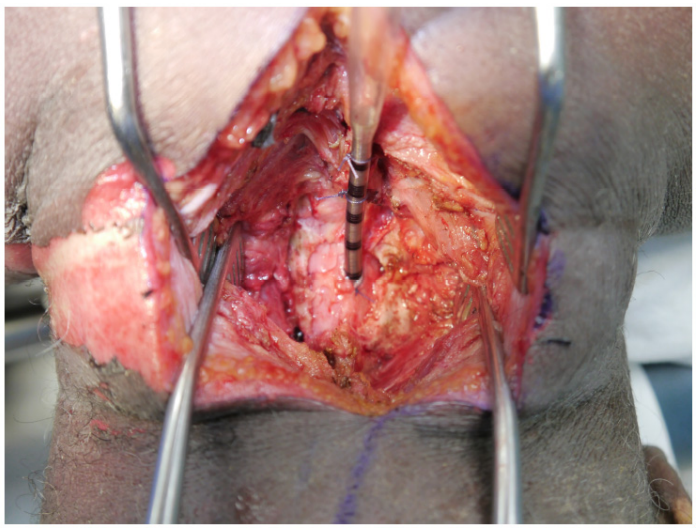
Richard Aaron Robison MD; Jesse Winer MD; Michael Minneti; Daniel R. Kramer MD; Ifije Ohiorhenuan MD, PhD; Steven L. Giannotta MD; Gabriel Zada MD

University of Southern California, Department of Neurosurgery

Introduction

The introduction of residents to basic procedural and surgical skills in a simulated environment prior to their performance in the patient environment is increasingly necessary. Current models for learning of ventriculostomy placement lack the visual, tactile and/or physiologic feedback of a live patient. We present a novel model of cadaveric CSF perfusion which successfully replicates all of these elements.

Figure 1: Cannula insertion



A 12 french pediatric arterial catheter is inserted via a midline mid-cervical durotomy to perfuse the CSF space

Methods

To prove feasibility, six fresh cadavers were obtained according to the standard operating procedure of the University of Southern California Fresh Tissue Dissection Laboratory. A mid-cervical laminectomy and midline durotomy were performed in each, and a 12 french pediatric arterial catheter was inserted into the subarachnoid space directed superiorly. The dura and skin were closed in a watertight fashion, and the subarachnoid space was infused with saline utilizing a Biomedicus BP80 bio-pump at 1100-1300rpm to achieve a CSF pressure of 15 to 30 mmHg. First year neurosurgical residents and neuro-critical care fellows attempted to place a standard frontal ventriculostomy via a twist-drill burr hole. Verification of placement into the ventricle was confirmed by return of CSF. Trainee confidence was assessed via a self-reported questionnaire.

Figure 2: Twist drill craniotomy

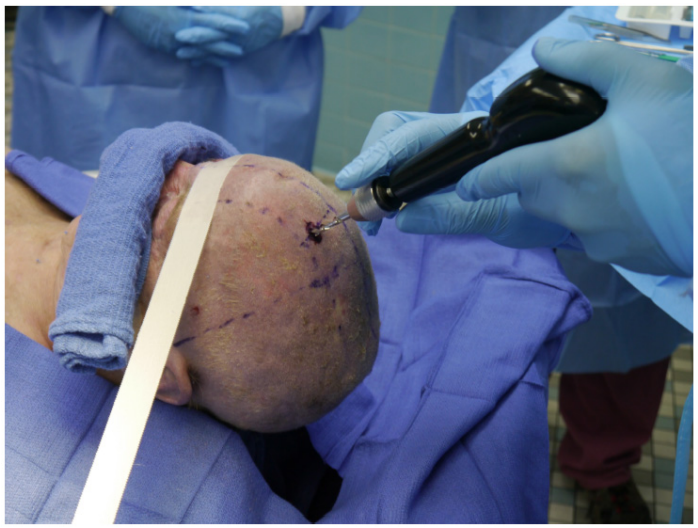
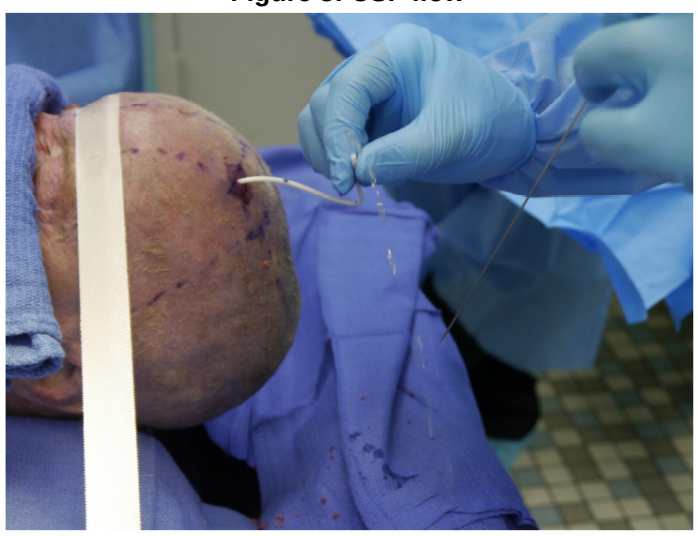


Figure 3: CSF flow



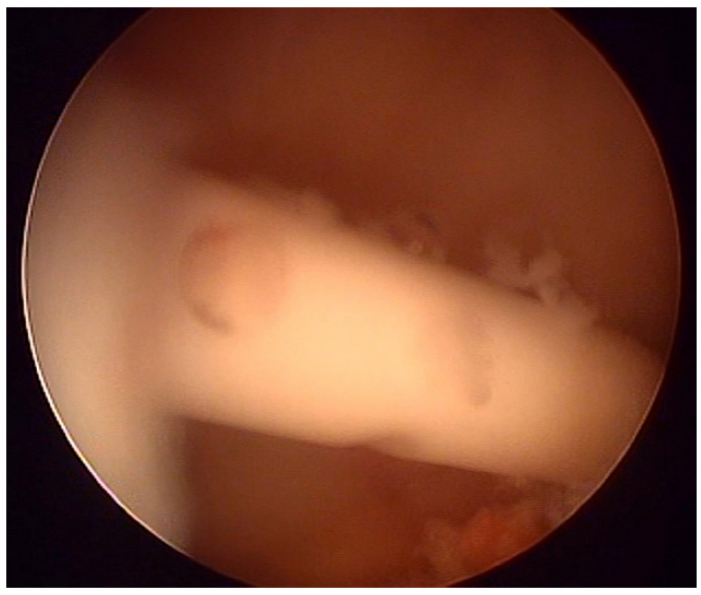
Results

Successful cannulation of the ventricular system was achieved in all cases, as confirmed by return of simulated CSF. In select cases, verification of catheter placement was also achieved by direct endoscopic visualization of the catheter within the ventricle. All participants stated that the tactile sensation of drilling and catheter placement accurately reflected that of a live patient, including entry into a pressurized ventricle and return of CSF. Self-reported trainee confidence was improved following the procedure in all cases.

Conclusions

A perfusion-based cadaveric model of CSF flow can accurately replicate the experience of ventriculostomy placement in a live patient. This constitutes a novel and valuable training model for ventriculostomy placement and potentially for other procedures involving the CSF space.

Figure 4: Endoscopic verification



In select cases, correct placement of the ventricular catheter was also confirmed via direct endoscopic visualization of the catheter tip within the ventricle.