

Virtual Reality in Neurosurgery

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Applications

A review was conducted by searching PubMed, PubMed Central, Google Scholar, the Scopus database, the Web of Science Core Collection database, and the SciELO citation index, from 1989-2021. An example of a search strategy used in PubMed Central is: "Virtual reality" [All Fields] AND ("neurosurgical procedures" [MeSH Terms] OR ("neurosurgical" [All Fields] AND "procedures" [All Fields]) OR "neurosurgical procedures" [All Fields] OR "neurosurgery" [All Fields] OR "neurosurgery" [MeSH Terms]). Using this search strategy, we identified 487 (PubMed), 1097 (PubMed Central), and 275 citations (Web of Science Core Collection database).

Articles were found and reviewed showing numerous applications of VR/AR in neurosurgery. These applications included their utility as a supplement and augment for neuronavigation in the fields of diagnosis for complex vascular interventions, spine deformity correction, resident training, procedural practice, pain management, and rehabilitation of neurosurgical patients. These technologies have also shown promise in other area of neurosurgery, such as consent taking, training of ancillary personnel, and improving patient comfort during procedures, as well as a tool for training neurosurgeons in other advancements in the field, such as robotic neurosurgery.

Mishra et al. present the first review of the immense possibilities of VR in neurosurgery, beyond merely planning for surgical procedures. The importance of VR and AR, especially in "social distancing" in neurosurgery training, for economically disadvantaged sections, for prevention of medicolegal claims and in pain management and rehabilitation, is promising and warrants further research ¹⁾.

Smart [haptic gloves](#) are a new technology emerging in [Virtual Reality](#) (VR) with a promise to enhance sensory feedback in VR. Boutin et al. presents one of the first attempts to explore its application to

neurosurgical training using VR-based surgery [simulators](#). They developed and evaluated a surgical simulator for [External Ventricular Drain Placement](#) (EVD), a common procedure in the field of neurosurgery. [Haptic gloves](#) are used in combination with a VR environment to augment the experience of [burr hole placement](#), and flexible [catheter](#) manipulation. The simulator was integrated into the training curriculum at the [2022](#) Canadian Neurosurgery Rookie Bootcamp. Thirty [neurosurgery residents](#) used the [simulator](#) where objective performance metrics and subjective experience scores were acquired. They provided the details of the simulator development, as well as the user study results and draw conclusions on the benefits added by the haptic gloves and future directions ²⁾

[Virtual Reality](#) in Neurosurgery included their utility as a supplement and augment for [neuronavigation](#) in the fields of diagnosis for complex [vascular interventions](#), [spine deformity](#) correction, [resident training](#), procedural practice, [pain management](#), and [rehabilitation](#) of neurosurgical patients. These technologies have also shown promise in other area of neurosurgery, such as consent taking, training of ancillary personnel, and improving patient comfort during procedures, as well as a tool for [training](#) neurosurgeons in other advancements in the field, such as [robotic neurosurgery](#).

Mishra et al. present the first [review](#) of the immense possibilities of VR in [neurosurgery](#), beyond merely [planning](#) for [neurosurgical procedures](#). The [importance](#) of VR and AR, especially in “social distancing” in [neurosurgery training](#), for economically disadvantaged sections, for [prevention](#) of medicolegal claims and in [pain management](#) and [rehabilitation](#), is promising and warrants further research ³⁾.

Ros et al. previously described the immersive tutorial, a 3D video (filmed from the first-person point of view), displayed on a VR application. This tool offers access to supplementary educational data in addition to the video. Here we attempt to assess improvement in learning a technique using this new educational format.

Material and methods: We selected a single neurosurgical technique for the study: external ventricular drainage. We wrote a technical note describing this procedure and produced the corresponding immersive tutorial. We conducted a prospective randomized comparative study with students. All participants read the technical note, and one group used the immersive tutorial as a teaching supplement. The students completed a multiple-choice questionnaire immediately after the training and again at six months.

Results: One hundred seventy-six fourth-year medical students participated in the study; 173 were included in assessing the immediate learning outcomes and 72 were included at the six-month follow-up. The VR group demonstrated significantly better short-term results than the control group ($P=0.01$). The same trend was seen at six months ⁴⁾.

Virtual reality simulator

see [Virtual reality simulator](#).

Virtual reality simulator for aneurysmal clipping surgery

see [Virtual reality simulator for aneurysmal clipping surgery](#).

1)

Mishra R, Narayanan MDK, Umana GE, Montemurro N, Chaurasia B, Deora H. Virtual Reality in Neurosurgery: Beyond Neurosurgical Planning. Int J Environ Res Public Health. 2022 Feb 2;19(3):1719. doi: 10.3390/ijerph19031719. PMID: 35162742; PMCID: PMC8835688.

2)

Boutin J, Kamoopuri J, Faieghi R, Chung J, de Ribaupierre S, Eagleson R. Smart haptic gloves for virtual reality surgery simulation: a pilot study on external ventricular drain training. Front Robot AI. 2024 Jan 10;10:1273631. doi: 10.3389/frobt.2023.1273631. PMID: 38269073; PMCID: PMC10806798.

3)

Mishra R, Narayanan MDK, Umana GE, Montemurro N, Chaurasia B, Deora H. [Virtual Reality](#) in Neurosurgery: Beyond [Neurosurgical Planning](#). Int J Environ Res Public Health. 2022 Feb 2;19(3):1719. doi: 10.3390/ijerph19031719. PMID: 35162742; PMCID: PMC8835688.

4)

Ros M, Debien B, Cyteval C, Molinari N, Gatto F, Lonjon N. Applying an immersive tutorial in virtual reality to learning a new technique. Neurochirurgie. 2020 Aug;66(4):212-218. doi: 10.1016/j.neuchi.2020.05.006. Epub 2020 Jul 2. PMID: 32623059.

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