Heads-up-display

- Operative Microscope In-Field Visualization of Confocal Laser Endomicroscopy Interface (Zeiss CONVIVO®)
- Minimally Invasive Approaches to Spinal Cerebrospinal Fluid Leak Repair: Current Strategies and a Novel Technique
- Prone transpsoas lateral interbody fusion with retractor-mounted camera and heads-up display: illustrative case
- A Multicenter Study Investigating the Surgeon Experience with a Robotic-Assisted Exoscope as Part of the Neurosurgical Armamentarium
- Virtual and Augmented Reality in Spine Surgery: A Systematic Review
- Intraoperative use of heads-up display in skull base surgery
- Segmentation techniques of brain arteriovenous malformations for 3D visualization: a systematic review
- Remote surgical education using synthetic models combined with an augmented reality headset

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Improvement of visualization tools in neurosurgery such as the exoscope has raised the question of how this technology compares to the conventional microscope for surgeon ergonomics, discomfort, and patient outcomes. Exoscopes have the advantage of greater optical zoom, resolution, and illumination at a lower light intensity. Heads-up display for both the primary surgeon and other assistants permits neutral positioning of the surgeons while placing the camera in more angled positions. In a survey sample, this study assesses the surgeon's experience utilizing a 3D exoscope in general neurosurgery cases.

Data were recorded by 8 surgeons at 5 separate hospitals utilizing a mobile phone application survey. Surgeons recorded information about case type, intraoperative clinical outcomes such as blood loss and extent of resection, whether fluorescence visualization was used, as well as surgeon pain when compared to matched cases using conventional tools.

A total of 155 neurosurgical cases were recorded in this multisite study, including 72% cranial cases and 28% spinal cases. Of the cranial cases, 76% were brain tumor resections (31% of which were brain metastases). Surgeons reported significantly less neck ($P < 0.0001$) and back ($P < 0.0001$) pain in cases when using the robotic exoscope compared with the conventional microscope or surgical loupes. Surgeons did not convert to a microscope in any case.

The exoscope provides excellent delineation of tissue with high resolution. Surgeon pain was markedly reduced with the robotic exoscope when compared with conventional technology, which may reduce work-related injury and fatigue, potentially leading to better patient outcomes [1)].

Salgado-Lopez et al. highlights the applications of virtual reality and heads-up display in skull base surgery by presenting the case of a 45-year-old woman with an incidental large clinoid meningioma extending into the posterior fossa. The patient underwent preoperative endovascular tumor embolization to facilitate tumor resection and reduce blood loss, followed by a right pterional craniotomy. The use of intraoperative Doppler, intraoperative neurophysiological monitoring, and endoscope-assisted microsurgery is also featured. A subtotal resection was planned given tumor

encasement of the posterior communicating and anterior choroidal arteries. No new neurological deficits were noted after the surgical procedure. The video can be found here: https://stream.cadmore.media/r10.3171/2021.10.FOCVID21177 [2)]

1)
Schupper AJ, Eskandari R, Kosnik-Infinger L, Olivera R, Nangunoori R, Patel S, Williamson R, Yu A, Hadjipanayis CG. A Multicenter Study Investigating the Surgeon Experience with a Robotic-Assisted Exoscope as Part of the Neurosurgical Armamentarium. World Neurosurg. 2023 May;173:e571-e577. doi: 10.1016/j.wneu.2023.02.094. Epub 2023 Feb 25. PMID: 36842529.
2)
Salgado-Lopez L, Oemke H, Feng R, Matsoukas S, Mocco J, Shrivastava R, Bederson J. Intraoperative use of heads-up display in skull base surgery. Neurosurg Focus Video. 2022 Jan 1;6(1):V2. doi: 10.3171/2021.10.FOCVID21177. PMID: 36284591; PMCID: PMC9557332.