

## Augmented and virtual reality as training tool for maxillofacial surgeons and neurosurgeons: is it the future?

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**Recent biotechnological advances, including three-dimensional microscopy and endoscopy, virtual reality, surgical simulation, surgical robotics, and advanced neuroimaging, have moulded the surgeon-computer relationship. For developing neurosurgeons and maxillofacial surgeons, such tools can reduce the learning curve, improve conceptual understanding of complex anatomy, and enhance visuospatial skills. However, current clinical trials in dental virtual reality must still be experimental.**

Recent biotechnological advances, including three-dimensional microscopy and endoscopy, virtual reality, surgical simulation, surgical robotics, and advanced neuroimaging, have moulded the surgeon-computer relationship. For developing neurosurgeons and maxillofacial surgeons, such tools can reduce the learning curve, improve conceptual understanding of complex anatomy, and enhance visuospatial skills (1-13). Craniomaxillofacial surgery comprises multiple surgical disciplines, including neurosurgery, plastic surgery, otolaryngology, ophthalmology, and oral

and maxillofacial surgery. These specialities are performing surgery in an era of evolving technology, cost containment, reduced resident work hours, and a focus on patient safety (14-18).

Robotic surgery is a promising field in neurosurgery and craniofacial surgery, which can currently also be used to train residents. However, before robotic assistance becomes commonplace in the neurosurgical and maxillofacial field, improvements and breakthroughs must occur in minimally invasive and endoscopic robotics-assisted surgical systems (19-34).

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Therefore, communication across different specialities remains a core element of cancer care. Communication skills are essential in establishing a good relationship with patients, but in the increasingly complex field of cancer treatment, oncologists and surgeons need to be equally skilled at communicating with and learning the art of those focused on other specialities (2).

The increasing techno-manual complexity of procedures and time constraints necessitates practical neurosurgical and maxillofacial training (12, 15, 35). Approaches including 3D printed brains, gelatin composite models, and virtual environments have been published (33). However, the quality of brain surgery simulation is limited due to discrepancies in visual and haptic experience, especially in brain tumor resection and following head and spinal injuries (36-48). In addition, the increasing interest and advancements in robotic spine surgery parallel a growing emphasis on maximizing patient safety and outcomes, as an increasing interest in minimally invasive spine surgery has further fueled robotic development, as robotic guidance systems are aptly suited for these procedures (49-63).

Similarly, clinical research related to virtual reality technologies in dental medicine revealed that these were predominantly used for educational motor skill training in university settings, for clinical analyses of complex maxillofacial surgical protocols, and to reduce surgical complications (64-128). Furthermore, virtual reality technology was also applied to investigate human anatomy and treat patients with dental phobia. However, current clinical trials in dental virtual reality must still be experimental (64).

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