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Virtual Reality Implementation in Neurosurgical Practice: The "Can't Take My Eyes Off You" Effect

Nörocerrahi Uygulamasında Sanal Gerçeklik Kullanımı: "Gözlerini Ayıramama" Etkisi

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ABSTRACT

During the last few years, virtual reality (VR) has been increasingly implemented in the neurosurgical practice. The scope of this paper is to briefly outline the educational role of this novel technology in training surgeons. At the same time, the ability of VR workstations such as the Dextroscope® to consistently simulate the surgical trajectory to the lesion-target is highlighted. The authors shed light to the current applications of VR systems in the neurosurgical field by describing not only the advantages of those systems, but their principal drawbacks as well. It seems that VR has come to stay and it is already the new best friend of residents due to its "Can't take my eyes off you effect".

KEYWORDS: Virtual reality, Neurosurgery, Education

ÖZ

Son birkaç yıl içinde sanal gerçeklik nörocerrahi uygulamalarında giderek daha fazla kullanılmaya başlanmıştır. Bu makalenin amacı bu yeni teknolojinin eğitim gören cerrahlar için eğitici rolünü kısaca vermektir. Aynı zamanda Dextroscope® gibi sanal gerçeklik çalışma istasyonlarının lezyona ve hedefe cerrahi yolu tutarlı bir şekilde simüle etme kapasitesi vurgulanacaktır. Yazarlar nörocerrahi alanında sanal gerçeklik için mevcut uygulamaları hem bu sistemlerin avantajlarını hem de temel çekinceleri tanımlayarak açıklamaktadır. Sanal gerçeklik artık aramıza katılmış gibidir ve şimdiden "Gözünü alamamak" etkisi sayesinde asistanların en iyi arkadaşı haline gelmektedir.

ANAHTAR SÖZCÜKLER: Sanal gerçeklik, Nöroşirürji, Eğitim

Sir,

Neurosurgery involves many operations in difficult-to-access areas (13). A solution to surgeons' training and improvement of surgical outcomes would be rehearsing the operations in animals. However, the high cost and the animal activists' complaints are some (and not the only) considerable drawbacks. Thus, simulation with the aid of virtual reality (VR) seems to be a promising new educational tool (2,10).

Such a VR stimulator commercially available is the Dextroscope® (Volume Interactions, Pte, Ltd.) (2,6). It processes data from computed tomography (CT), computed tomography angiography (CTA), magnetic resonance imaging (MRI), magnetic resonance angiography (MRA), and digital subtraction angiography (DSA) to create a VR environment with a stereoscopic view and certain manipulation of objects (3,5). It actually generates 3D data in such a form that the 3D shape of the target, its size and the ideal surgical corridor leading to it can be adequately comprehended by the users (8,10). After generating VR data for 3 or 4 cases, it seems that the procedure should take no more than 60 minutes to complete (3). Moreover, surgeons are allowed to interact with the target and try different approaches using 3D tools (instead of the conventional keyboard and mouse) (2,5,10), minimizing the anxiety associated with complex and technically demanding neurosurgical approaches (8).

This novel technology has been used in several clinical scenarios; cerebral arteriovenous malformations (9,12), aneurysms (10,11), cranial nerve decompression (in cases of trigeminal neuralgia and hemifacial spasm) (3,4,7), meningiomas (convexity, falcine or parasagittal) (8), ependymomas or subependymomas (1,10), and a great variety of deep-brain and skull base tumors (pituitary adenomas, craniopharyngiomas, arachnoid cysts, colloid cysts, cavernomas, hemangioblastomas, chordomas, epidermoids, meningiomas, gliomas, jugular schwannomas, aqueductal stenosis, stenosis of Monro foramen, hippocampal sclerosis) (5,6,10,13). Not only brain, but also spine pathology such as cervical spine fractures, syringomyelia, and sacral root neurinomas has been evaluated (10). In the majority of the patients, the preoperative surgical trajectory and the anticipated obstacles perfectly matched the actual intraoperative trajectory and obstacles met (3). In addition, the target's morphology and its anatomical relationships with critical surrounding structures (bone, parenchyma, nerves, and vessels) were in line with the preoperative VR evaluation (1,8).

As reported in the literature, users' experiences were more than satisfactory (10). If compared to virtual endoscopy, most neurosurgeons agree that the Dextroscope® presents two main advantages; first, it is stereoscopic (better spatial understanding) and second, it allows users to see the target from any angle (3,7). They commonly describe the VR process as "vivid", "demonstrative", "intuitive", "easy", "clarifying" and "very helpful" (3,10), as this VR workstation makes understanding of the demanding neurosurgical anatomy easier (1,6). It has been also suggested that it is useful for practicing hand-eye coordination, developing dexterity and new ideas for target approach (1). Furthermore, the Dextroscope® assists in defining the appropriate size of craniotomy, performing minimal amount of exploratory tissue dissection (4,8), and increasing the surgeon's confidence (3). Without any doubt, the integration of 3D imaging with stereoscopic vision improves decision making in patient management (1,4), increasing total resection rates, reducing blood loss, shortening operation duration and length of stay in the hospital, and improving quality of life (7,13).

As with any new tool, the Dextroscope® is not short of limitations. First, it requires a learning process of at least 3 or 4 cases. Second, its performance depends on the quality of the obtained radiological images. Third, it lacks the ability to simulate adverse operative events (hemorrhage, dissection difficulties). Fourth, the list price for a Dextroscope® system is approximately 175,000 US dollars, rendering it unaffordable for many institutions worldwide (6). Finally, a validated neuronavigation system for transferring virtual planning data to the real surgical procedure is not available yet (4).

In conclusion, the Dextroscope® has become neurosurgeons' (and especially residents') new best friend. This "can't take my eyes off you effect" in conjunction with the extraction of useful neurosurgical information seems to justify the extra cost that this new interactive educational technology imposes to the current neurosurgical practice. After all, operating means interacting.

Sincerely,

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