Virtual Reality Based Simulators For Cranial Tumor Surgery: A Systematic Review

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INTRODUCTION

Virtual reality (VR) simulators are increasingly being used in medicine, particularly in the surgical specialties for training, assessment, and presurgical planning. The use of VR is already a mainstay of other fields; however, the neurosurgical specialty has been slow to adopt the new technology. Recent investigations into VR’s validity and efficacy for cranial tumor resection have been undertaken and are reviewed in this article.

GOAL

Asses all current literature of cranial tumor surgery utilizing virtual reality for the purposes of pre-surgical planning and/or training.

METHODS

Unitizing PRISAMA guidelines, PubMed and Embase where systematically searched for all available articles from inception until May 25, 2017 regarding tumor resection for the purposes of presurgical planning or training. Articles included required the utilization of VR simulators that had both a virtual component and a physical interface; purely virtual or purely physical simulators were excluded.

RESULTS

Search results initially identified 1662 articles, which were then screened by titles, abstracts, and full text to yield 9 articles for analysis. These 9 articles were subdivided into 2 groups: 4 articles for presurgical planning and 5 articles for surgical training. The presurgical planning group included three studies of a case series design and one study of a prospective controlled study; surgical procedures included resection of tumors involving the primary motor cortex, sellar region tumors, cerebellar pontine angle meningiomas, and skull based tumors in general. Three used Dextroscope simulators, while one used an unidentified simulator. The surgical training group included 5 studies all of a cohort study design. Each study utilized the NeuroTouch simulator and used participants ranging from medical students, junior residents, senior residents, and neurosurgeons. Researchers used metrics such as percent tumor resected, percent normal brain tissue resected, and total path length to assess participants.

DISCUSSION

Each study involving presurgical planning demonstrates that VR can be successfully implemented and that neurosurgeons agree that VR is at least as good as current imaging; however, three of these studies lack control groups and thus there is no way to determine if VR is significantly better than standard presurgical planning. The fourth article does have a control group and the research determined that VR planned surgeries have significantly better KPS scores, shorter length of stay, and shorter operative time. These findings are the strongest evidence to-date and, while more studies will be required to confirm these findings, suggest VR will be a valuable tool in the near future. VR implementation for training has particularly appealing benefits including unlimited opportunity for practice without jeopardizing patient safety, and it is substantially cheaper than other methods. These articles demonstrated the validity of VR for training and established benchmarks by comparing residents to neurosurgeons. Overall the results were promising, but weaknesses in the literature remain. None of the articles sought to establish if skills acquired in VR translated into better operating room performance. Furthermore, much of the improvements are seen in medical students and junior residents which suggests that VR has diminishing returns as a resident progresses through their program. Future studies are required to determine if VR training improves operating room performance and if it can hasten the acquisition of skills.

CONCLUSION

VR for Presurgical planning shows promise in all four articles analyzed, demonstrating successful implementation and good outcomes for all procedures studied; however, it is unclear if there are significant differences when compared to standard planning. Future research should focus on implementation of VR for presurgical planning with control groups that tract patient outcomes (e.g. length of stay, functional scores) so that more reliable conclusions can be made. Articles involving training demonstrated face and construct validity with benchmarks that can accurately differentiate operator skill level; however, the beneficial effect of VR training is largely seen in medical students and junior residents. Furthermore, it is unclear if VR training translates into better operating room performance and future studies should focus on determining real world benefit to VR training.

Disclosures:

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