THREE-DIMENSIONAL PROJECTIONS OF BRAIN NEOPLASMS IN ONCOLOGICAL SURGERY PLANNING: AN INTEGRATIVE REVIEW

Maria Carolina Mota Mendes[1]
Wesley Lima Guimarães[1]
Gerley Adriano Miranda Cruz[1]
Jalsi Tacon Arruda[2]
Universidade Evangélica de Goiás – UniEVANGÉLICA[12]

ABSTRACT

INTRODUCTION: With the advancement of technological sciences, society has begun to question the application of these new instruments in the medical context, revolutionizing studies related to this area, particularly concerning technologies such as stereolithography. **OBJECTIVE:** To investigate the impact of using three-dimensional projections compared to the absence of these projections on the surgical strategies adopted for patients with brain neoplasms. **METHODOLOGY:** This is an integrative literature review. After searching the National Library of Medicine (PubMed), Virtual Health Library (BVS), and Google Scholar databases, followed by the application of eligibility and exclusion criteria, 10 articles were included in this study. **RESULTS:** In most of the assessments used to measure the effectiveness of this practice, the implementation of this model proved positive for potential interventions in different types of tumors—especially in diffuse low-grade gliomas (DLGGs)—whether through questionnaires or quantitative instruments. **CONCLUSION:** The studies demonstrated significant evolution regarding the use of brain three-dimensional projections, both related to the planning of surgical interventions and to the anatomical understanding of the neoplasms themselves.

KEYWORDS: Brain Neoplasms; Three-Dimensional Projections; Stereolithography; Neurosurgery

INTRODUCTION

Since the occurrence of the industrial revolution, which can be mentioned as the beginning of a technological revolution, society has questioned the application of technologies in all social areas, including the medical field. New applied sciences, such as ultrasonography, computed tomography (CT), magnetic resonance imaging (MRI), three-dimensional printing (3DP), and, more recently, the use of artificial intelligence (AI), have been revolutionizing medicine since their creation.

Three-dimensional printing applied to medicine, studied by Anderl et al. in 1994, already cited the combined use of CT images and 3DP of bones for surgeries in the field of orthopedics. According to the author, this use already facilitated the planning and visualization of the skeletal system, in addition to reducing surgical risks for patients. Over time, the orthopedist's research took on considerable proportions, encompassing various surgical areas, such as neurosurgery.

Over the years, however, the efficacy of using three-dimensional projections applied to medicine has been increasingly studied and questioned, especially regarding the details of their use in surgical centers. This conflict arises because the prototypes, however detailed they may be, are still artificial imitations of organs whose specific tissues and cells possess properties that can change the entire medical intervention strategy to avoid future complications for the patient. Thus, the discussion of whether or not to proceed with a technique that was positive in simulations, in real cases, stands out among professionals in the field.

Moreover, the questioning of the applicability of 3DP in surgeries takes on an even greater dimension in the oncological field, since malignant neoplasms mostly represent a risk to organic function and patient life. Therefore, when adding the oncological field to the neurosurgical field—whose system is sensitive and highly perilous during interventions—the debate on the application of three-dimensional projections becomes even more assiduous. In short, this study proposes to investigate the impact of using three-dimensional projections compared to the absence of these projections on the surgical strategies adopted for patients with brain neoplasms.

METHODOLOGY

This work is an integrative literature review and aims to analyze the applicability of using three-dimensional printing for planning surgical strategies. After searching the National Library of Medicine (PubMed), Virtual Health Library (BVS), and Google Scholar databases, followed by the application of eligibility and exclusion criteria, 10 articles were included in this study.

Only indexed studies published in English in the last 10 years that provided a quantitative and/or qualitative analysis of surgical interventions with three-dimensional projections were included. On the other hand, case reports, studies with incomplete access (i.e., those that provided only the abstract), and studies that did not directly address the theme of the study were excluded.

RESULTS

The integrative review encompassed a variety of studies that investigated the application of 3D printing in neurosurgery, particularly concerning brain tumors. Each study presented innovative methods and relevant results, allowing for a broader understanding of the efficacy of this technology in neuro-oncological surgical practices.

In the research by GOMEZ-FERIA, J. et al. (2021), which focused on the removal of diffuse low-grade gliomas (DLGGs), the use of multimodal magnetic resonance imaging information allowed for a more precise surgical approach. The 3D printing aimed not only at meticulous planning but also at preoperative education and training of residents in complex procedures involving DLGGs.

The study by MACKLE, E. C. et al. (2020) focused on surgical simulations for complex intracranial lesions, such as brain tumors and aneurysms. The 3D printing of craniocerebral models provided a platform for 49 simulated surgeries, highlighting the versatility of this approach in surgical practice.

In research conducted by MACKLE, E. C. et al. (2020), a unique approach was adopted, creating a patient-specific phantom using ultrasound and x-ray contrast. This customized model was successfully used in surgical simulations, demonstrating the applicability of 3D printing in creating training tools.

Another study conducted by JEISING, S. et al. (2024) combined 3D printing with mixed reality technology for comprehensive neurosurgical training, from planning to surgery execution. This innovative approach highlights the integration of different technologies to enhance surgeons' training capabilities.

The fifth research, conducted by GARGIULO, P. et al. (2017), explored new directions in 3D medical modeling, focusing on neurosurgical anatomy and functions. The study assessed anatomical accuracy and fiber display, introducing advanced approaches in the use of 3D printing.

Additional studies investigated the simulation of specific procedures, such as anterior clinoidectomy and removal of skull base tumors, as demonstrated by OKONOGI, S.

et al. (2017). These studies emphasized the importance of accurate anatomical reproduction and the usefulness of 3D printed models in clinical practice.

Regarding clinical validation, a specific study conducted by LAN, Q. et al. (2016) sought to evaluate the practical utility of 3D printing in creating patient-specific models for brain tumors. This practical focus highlights the clinical applicability of these models.

Other research, such as that by DHO, Y. S. et al. (2021), addressed rapid prototyping methods for diffuse low-grade gliomas, emphasizing the importance of the rapid availability of accurate models for neurosurgical practice.

Finally, a study conducted by THAWANI, J. P. et al. (2017) used 3D printing to create customized cranial nerve models, allowing for detailed preoperative visualization and a safer approach in the removal of skull base tumors.

CONCLUSION

According to the presented studies, it is possible to perceive the breadth of this theme, with emphasis on oncological neurosurgical interventions, enabling the effective use of this technology in the medical field. In short, frequent work on understanding the application of stereolithography regarding the benefits of this practice becomes relevant, considering the importance of providing more efficient approaches for patient health.

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