Asia-Pacific Journal of Oncology Nursing 11 (2024) 100526

Contents lists available at ScienceDirect

Asia-Pacific Journal of Oncology Nursing

journal homepage: www.apjon.org

Editorial

Exploring tumor-related language disorders: Pretreatment and post-treatment considerations

Introduction

Over the past two decades, research in the field of neuro-oncology has focused on investigating the impairments that arise following surgical treatments and on developing strategies to alleviate them, particularly through brain mapping and behavioral intraoperative assessment.[1,2] However, studying the deficits that brain tumors cause to language prior to any treatment is equally important as these preoperative deficits can not only offer crucial insights regarding the first clinical symptoms of the disease, but they can also provide a unique window into the intricacies of the language system. Furthermore, studying the different patterns of neuroplasticity can enhance our understanding of how the language network is reshaped after the occurrence of a brain tumor or its surgical removal, ultimately fostering improvements in the overall quality of life for patients undergoing treatment for brain tumors. The present communication briefly discusses the relationship between brain tumors and language functions within the context of neuro-oncology.

Pretreatment language deficits

The language deficits caused by brain tumors or their surgical removal have been previously defined as *cancer-* or *tumor-related aphasias*. Several studies, especially during the early years of studying the consequences of brain tumors in language, attempted to describe these deficits according to the traditional syndrome taxonomy.[3–5] Although all these studies come from different eras and different research groups, they share a common finding, that is, mild anomic aphasia is the most common aphasic symptom, whereas global aphasia is very rare. However, the term "aphasia" and the traditional stroke taxonomy (e.g., Broca's or Wernicke's) have been built on anatomical models of language that are centered around cerebral arterial territories. Therefore, it is unknown if they are adequate to provide accurate descriptions of the impairments caused by brain tumors, which do not adhere to cerebral territorial boundaries. We consider the term "*tumor-related language disorders*" as more representative since it provides a more board scope of deficits related to language.[6]

The specific language errors emerging in tumor-related language disorders are not very different from vascular aphasias since they relate to language itself, regardless of the underlying pathology. While anomias and word-finding difficulties are the most prominent language symptoms, even from the early stages of the disease, other errors should not be excluded. For instance, circumlocutions, agrammatism, semantic paraphasias, phonological paraphasias, neologisms, and various acquired dyslexia forms have also been reported.[5,7] Interestingly, anomic errors and word-finding difficulties seem to be independent of tumor location, which is not surprising, given the number of cortical and subcortical areas involved in naming.[8,9]

Neuroplasticity and tumor-related language disorders

Compared to other pathologies where lesions develop suddenly, such as strokes or traumatic brain injuries, brain tumors grow slowly, allowing *neuroplasticity* to reorganize and relocate brain functions, thereby slowing down the manifestation of symptoms or even temporally reducing their severity.[10,11] Such phenomena often challenge the traditional localization view of language, as evidenced by numerous cases of patients with similar symptoms but very dissimilar brain tumors or by patients with similar brain tumors that exhibited different types of language impairments.[10,11] The current literature is not conclusive regarding the exact factors that can accurately predict the type and severity of linguistic deficits. Notably, tumor grade emerges as a critical factor since it has been argued that slow-growing low-grade gliomas typically induce mild symptoms, whereas aggressive and infiltrative tumors are more likely to cause severe language deficits.[2,12] Regarding tumor volume and location, in a promising research, Iuvone et al.[13] concluded that tumor location has more predictive value of neurocognitive deficits than tumor volume as it was found that large tumors may cause fewer symptoms than smaller tumors, which are located in essential for language cortical areas.

The dynamic nature of reorganization that is triggered by neuroplasticity at the pretreatment stage also highlights the importance of brain mapping during awake brain surgery. According to Duffau's "temporospatial hierarchical model for neuroplasticity," functions can be preserved within the tumor or relocated to perilesional, ipsilateral, or even contralateral cortical areas, potentially unrelated to language.[10] Therefore, language mapping using electrical stimulation becomes indispensable to identify eloquent cortical areas and protect them from the resection process.

Moreover, neuroplasticity's influence extends to the postoperative phase, as Duffau's model argues that different neuroplasticity patterns (e.g., functions within the tumor, perilesional, ipsilateral, or contralateral) have different predictive values regarding the recovery process, that is, reorganization approximate to the lesion typically leads to better outcomes compared to contralateral reorganization.

Iatrogenic (post-treatment) language deficits

The term *iatrogenic deficits* refer to impairments resulting from brain tumor treatment, irrespective of the modality used, whether it involves surgery (under general anesthesia or awake), radiotherapy, or chemotherapy.

https://doi.org/10.1016/j.apjon.2024.100526
Received 21 May 2024; Accepted 22 May 2024

Awake brain surgery typically results in lower rates of new neurological deficits, including language impairments, compared to procedures under general anesthesia; however, postoperative deficits remain a concern. Distinguishing between transient and permanent deficits is crucial since certain symptoms, especially those caused by transient factors like cerebral edema, may resolve quickly, unlike deficits resulting from vascular injury or damage to eloquent brain regions, which could lead to more permanent language impairments. This distinction is frequently observed in studies focusing on post-treatment language disorders, often revealing transient (and in many cases severe) deficits following awake craniotomies, which rarely result in permanent impairment. For instance, Gravesteijn et al.[14] reported that 25% of patients who underwent awake brain surgery and 11% of those who underwent surgery under general anesthesia experienced early severe neurological deficits, including aphasia. While a significant proportion of these deficits were transient for both groups, patients who underwent surgery under general anesthesia developed more (new) permanent neurological deficits than those who had awake brain surgery. Regarding the type of postoperative deficit (regardless of the surgery type), it has been argued again that anomias and word-finding difficulties are the most dominant language symptoms.[15] However, various other types of linguistic deficits are also possible, and in most cases, they can be predicted by the location of the resection. For example, resection of the left supplementary motor area (SMA) may lead to a sudden inability to initiate speech and language, or resection of white matter tracts originating from the left frontal operculum may lead to language production deficiencies.

Radiotherapy, on the other hand, may induce transient impairments during the acute phase, whereas delayed deficits may lead to permanent impairments, such as dementia and aphasia, due to radiation necrosis. Distinguishing radiotherapy-related deficits from those caused by chemotherapy is difficult due to concurrent therapy administration in most cases. Long-term deficits associated with chemotherapy, commonly referred to as “chemo brain,” encompass a wide range of cognitive functions, including language, executive functions, learning, memory, visuospatial abilities, abstract reasoning, and motor coordination. Understanding and effectively managing iatrogenic language deficits are paramount for optimizing patient outcomes and enhancing quality of life following brain tumor treatment.

Therapy considerations and quality of life

In the literature, there is a general consensus that postoperative therapeutic intervention, particularly speech and language therapy, is highly beneficial for patients undergoing awake brain surgery and experiencing permanent tumor-related language disorders. For example, Thomas et al.[16] reported very positive outcomes from language intervention and proposed that all patients who undergo tumor surgery should be followed by an interdisciplinary team. Another study found that patients who received speech therapy the first three months after the operation were more likely to recover to preoperative levels.[17] Similarly, Duffau et al.[18] found that all tumor patients who went through speech and language therapy demonstrated normal scores on the Boston Diagnostic Aphasia Examination at the postoperative assessment (3 months later). Additionally, they reported that all patients returned to the same social and occupational levels as before the operation. However, the impact of brain tumors on patients’ health-related quality of life is generally considered understudied, mainly due to the often-fatal outcome of the disease and the relatively low incidence of brain tumors.[19,20]

According to the International Classification of Functioning, Disability and Health model (ICF; World Health Organization [WHO], 2001), brain tumors affect body functions, whereas the language impairment might result either from tumor growth or tumor removal. With respect to activity, the impact of language disorders on everyday life can be devastating as adequate communication abilities are mandatory for most daily activities.[20,21] The activity limitations may be also reflected in patient's participation in social life. Similarly to poststroke aphasia, tumor-related language disorders may lead to social isolation, loss of employment, and reduced leisure activities, diminishing patient's psychosocial well-being.

Conclusions

In conclusion, the field of tumor-related language disorders remains largely unexplored, particularly in the pretreatment stage. The conventional syndrome classification, primarily designed for stroke-based aphasias, may be inadequate to capture the complexities of language deficits in brain tumor patients, where lesions are not centered around cerebral arterial territories and neuroplasticity challenges traditional localization views. Although word-finding difficulties are frequently cited as the predominant symptom, both before and after treatment, there is a scarcity of comprehensive studies that thoroughly explore language deficits. Delving into the intricate relationship between tumor-related language disorders and neuroplasticity promises valuable insights and improvements into early symptomatology and detection, intraoperative assessments, and postoperative trajectories. Bridging this gap in understanding holds the potential to refine clinical practices and optimize outcomes for patients who struggle with the challenges posed by tumor-related language disorders.

Funding

This study received no external funding.

CRediT authorship contribution statement

Christos Papatzalas: Visualization, Investigation, Methodology, Writing – Original Draft. **Ilias Papathanasiou**: Conceptualization, Visualization, Supervision, Writing – Reviewing and Editing. All authors had full access to all the data in the study, and the corresponding author had final responsibility for the decision to submit for publication. The corresponding author attests that all listed authors meet authorship criteria and that no others meeting the criteria have been omitted.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Declaration of generative AI and AI-assisted technologies in the writing process

No AI tools/services were used during the preparation of this work.

References

1. De Witt Hamer PC, Robles SG, Zwinderman AH, Duffau H, Berger MS. Impact of intraoperative stimulation brain mapping on glioma surgery outcome: a meta-analysis. *J Clin Oncol*. 2012;30(20):2559–2565. https://doi.org/10.1200/JCO.2011.38.4818.
2. van Kessel E, Baumfalk AE, van Zandvoort MJE, Robe PA, Snijders TJ. Tumor-related neurocognitive dysfunction in patients with diffuse glioma: a systematic review of neurocognitive functioning prior to anti-tumor treatment. *J Neuro Oncol*. 2017;134(1):9–18. https://doi.org/10.1007/s11060-017-2503-z.
3. Kazner M. Early symptoms of aphasia with brain tumours. *J Nerv Ment Dis*. 1942;95(6):702–720.
4. Armstrong DJ, Horner J, Fedor KH, Massey EW. Aphasia associated with intracerebral neoplasms. In: Brookshire R, ed. *Clinical Aphasiology: Proceedings of the Conference 14*. Seabrook Island, SC Minneapolis, MN: BRK Publishers; 1984:85–93.
5. Haas J, Vogt G, Schiemann M, Patzold U. Aphasia and non-verbal intelligence in brain tumour patients. *J Neurol*. 1982;227(4):209–218. https://doi.org/10.1007/BF00313388.
6. Papatzalas C, Fountas K, Kapsalaki E, Papathanasiou I. Language disorders in neurosurgery. In: Coppens P, Papathanasiou I, eds. *Aphasia and Related Neurogenic*

Communication Disorders. 3rd ed. Burlington, MA: Jones and Bartlett Publishers; 2021:581–601.
7. Tomasino B, Ius T, Skrap M, Luzzatti C. Phonological and surface dyslexia in individuals with brain tumors: performance pre-, intra-, immediately post-surgery and at follow-up. *Hum Brain Mapp*. 2020;41(17):5015–5031. https://doi.org/10.1002/hbm.25176.
8. Anderson SW, Damasio H, Tranel D. Neuropsychological impairments associated with lesions caused by tumor or stroke. *Arch Neurol*. 1990;47(4):397–405. https://doi.org/10.1001/archneur.1990.00530040039017.
9. Basso A. *Aphasia and its Therapy*. Oxford: Oxford University Press; 2003.
10. Duffau H. Brain plasticity and tumors. *Adv Tech Stand Neurosurg*. 2008;33:3–33. https://doi.org/10.1007/978-3-211-72283-1_1.
11. Partovi S, Jacobi B, Rapps N, et al. Clinical standardized fMRI reveals altered language lateralization in patients with brain tumor. *AJNR Am J Neuroradiol*. 2012;33(11):2151–2157. https://doi.org/10.3174/ajnr.A3137.
12. Whittle IR, Pringle AM, Taylor R. Effects of resective surgery for left-sided intracranial tumours on language function: a prospective study. *Lancet*. 1998;351(9108):1014–1018. https://doi.org/10.1016/S0140-6736(97)08295-0.
13. Iuvone L, Peruzzi L, Colosimo C, et al. Pretreatment neuropsychological deficits in children with brain tumors. *Neuro Oncol*. 2011;13(5):517–524. https://doi.org/10.1093/neuonc/nor013.
14. Gravesteijn BY, Keizer ME, Vincent AJPE, Schouten JW, Stolker RJ, Klimek M. Awake craniotomy versus craniotomy under general anesthesia for the surgical treatment of insular glioma: choices and outcomes. *Neurol Res*. 2018;40(2):87–96. https://doi.org/10.1080/01616412.2017.1402147.
15. Davie GL, Hutcheson KA, Barringer DA, Weinbers JS, Lewin JS. Aphasia in patients after brain tumour resection. *Aphasiology*. 2009 Sep;23(9):1196–1206. https://doi.org/10.1080/02687030802436900.
16. Thomas R, O'Connor AM, Ashley S. Speech and language disorders in patients with high grade glioma and its influence on prognosis. *J Neuro Oncol*. 1995;23(3):265–270. https://doi.org/10.1007/BF01059960.
17. Papagno C, Gallucci M, Casarotti A, et al. Connectivity constraints on cortical reorganization of neural circuits involved in object naming. *Neuroimage*. 2011 Apr 1;55(3):1306–1313. https://doi.org/10.1016/j.neuroimage.2011.01.005.
18. Duffau H, Lopes M, Arthuis F, et al. Contribution of intraoperative electrical stimulations in surgery of low grade gliomas: a comparative study between two series without (1985-96) and with (1996-2003) functional mapping in the same institution. *J Neurol Neurosurg Psychiatry*. 2005 Jun;76(6):845–851. https://doi.org/10.1136/jnnp.2004.048520.
19. Efficace F, Bottomley A. Health related quality of life assessment methodology and reported outcomes in randomised controlled trials of primary brain cancer patients. *Eur J Cancer*. 2002 Sep;38(14):1824–1831. https://doi.org/10.1016/s0959-8049(02)00173-9.
20. Taphoorn MJB. Quality of life in low-grade gliomas. In: Duffau H, ed. *Diffuse Low-Grade Gliomas in Adults*. London, UK: Springer; 2013:205–217. https://doi.org/10.1007/978-1-4471-2213-5_14.
21. Banerjee P, Leu K, Harris RJ, et al. Association between lesion location and language function in adult glioma using voxel-based lesion-symptom mapping. *NeuroImage. Clinical*. 2015;9:617–624. https://doi.org/10.1016/j.nicl.2015.10.010.

Christos Papatzalas
Department of Speech and Language Therapy, University of the Peloponnese, Kalamata, Greece

Ilias Papathanasiou*
Department of Speech and Language Therapy, University of Patras, Patras, Greece
Medical School, National Kapodistreian University of Athens, Athens, Greece

* *Corresponding author.*
E-mail address: ipapatha@upatras.gr (I. Papathanasiou).