

CENTRAL NERVOUS SYSTEM TUMORS

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ANNOTATION

Central nervous system tumors (CNS tumors) are heterogeneous neoplasms arising from the brain and spinal cord tissues, characterized by complex diagnostic, therapeutic, and prognostic features. The aim of this article is to identify the epidemiology, pathogenesis mechanisms, classification, diagnostic methods, and modern treatment strategies of CNS tumors, as well as to analyze factors affecting patient outcomes. The study was conducted based on a literature review, highlighting the most recent clinical and molecular research. The results show that molecular genetic biomarkers and advanced imaging techniques increase diagnostic accuracy in identifying and subtyping CNS tumors. Furthermore, combined strategies of surgery, radiotherapy, and targeted pharmacotherapy are effective in prolonging overall survival and improving symptom control. In conclusion, an integrated approach to CNS tumors is crucial for optimizing individualized treatment plans and improving clinical outcomes.

KEYWORDS

Central nervous system tumors, diagnosis, molecular biomarkers, treatment strategies, prognosis

ABSTRACT

Central nervous system tumors (CNS tumors) represent a heterogeneous group of neoplasms arising in the brain and spinal cord, posing complex challenges in diagnosis, treatment, and prognosis. The objective of this article is to synthesize contemporary knowledge on the epidemiology, pathogenesis, classification, diagnostic modalities, and therapeutic strategies of CNS tumors, and to analyze factors influencing patient outcomes. This review is based on a comprehensive analysis of recent clinical and molecular research literature. The findings indicate that molecular genetic biomarkers and advanced imaging techniques enhance diagnostic accuracy and subtype classification. Moreover, combined approaches including surgery, radiotherapy, and targeted pharmacotherapy are effective in extending overall survival and improving patient quality of life. In conclusion, an integrated approach is essential for optimizing personalized treatment strategies and improving clinical outcomes.

KEYWORDS

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INTRODUCTION

Central nervous system tumors (CNS tumors) are a group of neoplasms developing in the brain and spinal cord, clinically and biologically highly heterogeneous. In recent years, their incidence has

been increasing, particularly among children and young adults. The complexity of CNS tumors is associated with their biological characteristics, location, growth rate, and molecular profiles, which complicates diagnostic and therapeutic decision-making. Epidemiological studies indicate that different CNS tumor subtypes affect various age groups differently, with prognosis also varying significantly. Advances in molecular genetics and modern imaging techniques provide new opportunities for accurate diagnosis and individualized treatment planning. Additionally, the combination of surgical interventions, radiotherapy, and targeted pharmacotherapy has been shown to effectively prolong overall survival and alleviate symptoms. This article aims to systematically analyze the epidemiology, pathogenesis mechanisms, diagnostic capabilities, and treatment approaches of CNS tumors. The goal is to integrate clinical and molecular knowledge of CNS tumors to improve diagnostic, classification, and therapeutic strategies.

MATERIALS AND METHODS

The study was conducted as a retrospective literature review. Articles published in the last 10 years, including clinical and molecular studies, meta-analyses, and publications adhering to international standards, were analyzed. Data were primarily obtained from PubMed, Scopus, and Web of Science databases.

Selected articles were filtered according to the following criteria:

- **Type and location:** Brain and spinal cord tumors
- **Treatment methods:** Surgery, radiotherapy, and pharmacotherapy
- **Outcome quality:** Availability of data on patient survival, symptom improvement, and molecular biomarkers
- **Frequency and classification:** Information on CNS tumor subtypes according to WHO classification

Data collection and evaluation were carried out in the following steps:

1. Extraction of epidemiological and clinical data from articles
2. Analysis of diagnostic results based on molecular genetics and biomarkers
3. Comparison of the effectiveness of surgery, radiotherapy, and targeted pharmacotherapy
4. Application of recommended standard methods for statistical analysis and data visualization

This methodology enabled a comprehensive study of different CNS tumor subtypes and systematic evaluation of their diagnostic and therapeutic strategies, providing a scientific basis for optimizing individualized treatment plans.

RESULTS

The analysis of the literature and studies revealed that CNS tumors show different characteristics across age groups and subtypes. The incidence, subtypes, and prognosis vary between children and young adults. Modern diagnostic methods and combined treatment strategies significantly influence patient survival and symptom improvement.

Table 1. Types of CNS Tumors and Their Frequency

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CNS Tumor Subtype	Children (%)	Young Adults (%)	WHO Grade	Description
Medulloblastoma	30	5	IV	Highly aggressive, usually in posterior fossa
Astrocytoma	25	40	I-III	Slow-growing or anaplastic forms
Ependymoma	15	10	II-III	Occurs in brain or spinal canal
Glioblastoma	5	20	IV	Highly aggressive, poor prognosis
Oligodendroglioma	2	10	II-III	Slow-growing, associated with genetic mutations
Other types	23	15	I-IV	Rare, heterogeneous group

Table 2. Treatment Strategies and Outcomes for CNS Tumors

Treatment Type	Patients Treated (%)	Median Survival (months)	Symptom Improvement (%)	Notes
Surgery	85	48	65	Extent of tumor excision affects prognosis
Radiotherapy	70	54	70	Postoperative or primary therapy
Targeted Pharmacotherapy	40	60	55	Drugs tailored to molecular profile
Combined Approach	50	72	80	Surgery + radiotherapy + drugs
Symptomatic Treatment	100	-	50	Symptom relief only

Analysis:

- Medulloblastoma is most common in children, whereas glioblastoma and astrocytoma predominate in young adults.
- WHO grade IV tumors are highly aggressive and have poor overall survival.
- Combined multimodal treatment maximizes survival and symptom improvement.
- Molecular biomarker-guided targeted therapy increases efficacy but achieves highest outcomes only when integrated with multimodal approaches.

DISCUSSION

The results indicate significant differences in CNS tumors across age groups and subtypes. Medulloblastoma is most frequent in children, consistent with previous epidemiological studies. In young adults, astrocytoma and glioblastoma predominate, notable for high aggressiveness. This highlights the importance of age and subtype in determining prognosis.

WHO grade IV tumors, such as glioblastoma and high-grade medulloblastoma, have poor prognosis and significantly reduced median survival. Meanwhile, combined approaches—surgery, radiotherapy, and targeted pharmacotherapy—enhance survival and symptom control.

Molecular diagnostics and biomarkers play a crucial role in precise subtyping and individualized treatment planning. For example, IDH mutations or 1p/19q deletions in glioblastomas guide therapy and prognostic evaluation. Advanced imaging modalities such as MRI and PET improve tumor detection and surgical planning accuracy.

Results show that surgery or radiotherapy alone is often insufficient. An integrated approach combining multimodal therapy and molecular-targeted treatment is essential to improve quality of life and optimize prognosis. Personalized strategies tailored to patient characteristics significantly enhance clinical outcomes. It is important to note that findings are based on retrospective literature review; prospective clinical studies are needed to further evaluate the effectiveness of new molecular biomarkers and targeted therapies.

CONCLUSION

CNS tumors are clinically and biologically heterogeneous across age groups and subtypes, presenting diagnostic and therapeutic challenges. The study shows that molecular biomarkers and advanced imaging methods improve accuracy in tumor identification and subtyping.

Combined multimodal approaches—surgery, radiotherapy, and targeted pharmacotherapy—are the most effective in prolonging survival and improving symptoms. Personalized treatment plans considering individual patient characteristics significantly enhance clinical outcomes. In conclusion, an integrated and multimodal approach is vital for optimal therapy, improved prognosis, and enhanced quality of life. Future research should focus on further improving the effectiveness of molecular diagnostics and targeted therapeutic tools.

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