

Neuro-Oncology in Transition: Molecular Classification and Emerging Therapies for Brain Tumors

Mansurov Sardor Vali o'g'li

Asia International University, Bukhara, Uzbekistan

Abstract

Brain tumors represent a diverse spectrum of neoplasms with distinct histopathological and molecular characteristics. The World Health Organization (WHO) 2021 classification integrates molecular parameters such as IDH mutation status, 1p/19q codeletion, and MGMT promoter methylation, redefining diagnostic and therapeutic paradigms. Glioblastoma remains the most aggressive primary brain tumor, with limited prognosis despite maximal safe resection, radiotherapy, and chemotherapy. Novel approaches, including targeted therapies, tumor-treating fields, immunotherapies, and liquid biopsies, are advancing the field of neuro-oncology. This review summarizes current knowledge on epidemiology, classification, clinical manifestations, diagnostic strategies, and modern treatment approaches.

Keywords: brain tumors, glioblastoma, IDH mutation, targeted therapy, immunotherapy, tumor-treating fields.

Introduction

Primary central nervous system (CNS) tumors account for approximately 1.4% of all cancers and 2.4% of cancer-related deaths globally. Their impact is disproportionate due to the delicate intracranial environment, neurological deficits, and limited therapeutic options. Secondary brain tumors, particularly metastases, are even more common and occur in up to 20–40% of patients with systemic cancer.

The introduction of molecular diagnostics has transformed the field of neuro-oncology. Unlike the purely histopathological classifications used in the past, current systems rely on molecular signatures that have prognostic and therapeutic implications.

Classification of Brain Tumors

WHO 2021 Classification

- Gliomas, glioneuronal, and neuronal tumors: IDH-mutant astrocytomas vs. IDH-wildtype glioblastomas
- Meningiomas: Now classified with molecular subgroups
- Embryonal tumors: Including medulloblastoma subtypes (WNT-activated, SHH-activated, group 3, group 4)
- Other rare entities: Pineal tumors, ependymomas with molecular stratification

Table 1. Molecular Markers with Prognostic Value in Brain Tumors

Marker	Associated Tumor	Prognostic Significance
IDH mutation	Astrocytoma, oligodendroglioma	Improved survival
1p/19q codeletion	Oligodendroglioma	Favorable prognosis, chemo-sensitive
MGMT promoter methylation	Glioblastoma	Better response to temozolomide
TERT promoter mutation	Glioblastoma	Poorer prognosis

Clinical Manifestations

- Raised intracranial pressure: Morning headaches, nausea, vomiting, papilledema
- Focal neurological deficits: Hemiparesis, aphasia, visual field defects

- Seizures: More common in low-grade gliomas
- Neurocognitive impairment: Executive dysfunction, memory loss
- Endocrine dysfunction: In pituitary adenomas

Diagnostic Approaches

Neuroimaging

- MRI with gadolinium: Gold standard; advanced sequences (perfusion, diffusion, MR spectroscopy) aid in grading.
- PET imaging: Amino acid PET tracers improve detection of recurrence vs. necrosis.

Liquid Biopsy

- Analysis of circulating tumor DNA (ctDNA) and extracellular vesicles from CSF or plasma provides non-invasive biomarkers.

Histopathology and Molecular Profiling

- Stereotactic biopsy or resection specimen remains definitive.
- Next-generation sequencing (NGS) enables precise molecular classification.

Treatment Strategies

Surgery

Maximal safe resection is the cornerstone. Awake craniotomy, intraoperative MRI, and fluorescence-guided surgery (5-ALA) enhance extent of resection.

Radiotherapy

- Fractionated external beam radiotherapy (60 Gy in 30 fractions for glioblastoma)
- Proton therapy and stereotactic radiosurgery for selected cases

Chemotherapy

- Temozolomide: Standard of care with radiotherapy in glioblastoma
- PCV regimen: Used for oligodendrogliomas with 1p/19q codeletion

Targeted and Immunotherapies

- Bevacizumab: Anti-VEGF therapy for recurrent glioblastoma
- Checkpoint inhibitors (nivolumab, pembrolizumab): Under investigation
- CAR-T cell therapy: Promising in early clinical trials

Novel Modalities

- Tumor Treating Fields (TTFs): Alternating electric fields that disrupt mitosis
- Oncolytic viruses: Experimental therapeutic direction

Prognosis and Future Directions

Prognosis varies significantly with molecular subtype. IDH-mutant gliomas show markedly improved outcomes compared to IDH-wildtype glioblastomas. Integration of precision oncology, AI-based radiomics, and immunogenomics is expected to redefine future management.

References

1. Толибов, Ф. (2024). ИММУННАЯ СИСТЕМА: АНАТОМИЯ ЛИМФАТИЧЕСКОЙ СИСТЕМЫ И МЕХАНИЗМЫ ИММУННОГО ОТВЕТА. Журнал академических исследований нового Узбекистана, 1(2), 55-58.
2. Farxodivich, T. F. (2024). The Syndrome of External Secretory Function Insufficiency is a Common Complication of Chronic Pancreatitis. American Journal of Bioscience and Clinical Integrity 1 (10), 90-95
3. Farxodivich, T. F. (2024). Clinical Characteristics of Gastritis in Digestive Diseases. Research Journal of Trauma and Disability Studies, 3(3), 294-299.

4. Farxodovich, T. F. (2024). INFECTION OF COVID-19 ON COGNITIVE FUNCTIONS. SCIENTIFIC JOURNAL OF APPLIED AND MEDICAL SCIENCES, 3(4), 325-330.
5. Tolibov F.F. - VIOLATION OF PLATELET AGGREGATION AND IMBALANCE OF HEMOSTASIS IN PATIENTS WITH CHRONIC VIRAL HEPATITIS C//New Day in Medicine 6(68)2024 264-268 <https://newdayworldmedicine.com/en/article/3758>
6. o'g'li, K. S. M. (2025). LUMBAR DISC HERNIATION: PATHOGENESIS, DIAGNOSIS, AND MODERN TREATMENT APPROACHES. International Journal of Cognitive Neuroscience and Psychology, 3(9), 33–38.
7. Jabborov Sherbek Otabek o'g'li. (2025). GASTRITS: ETIOLOGY AND TREATMENT. <https://doi.org/10.5281/zenodo.15070415>
8. Vali o'g'li, M. S. (2024). KIDNEY CANCER: EPIDEMIOLOGY AND
9. TREATMENT. EUROPEAN JOURNAL OF MODERN MEDICINE AND PRACTICE, 4(11), 459–463.
10. Vali o'g'li, M. S. KIDNEY CANCER: EPIDEMIOLOGY AND TREATMENT.
11. Valiyevich, M. S. (2024). Specific Morphofunctional Characteristics of the Kidney Caused by Brain Damage in Various Emergency Situations. Research Journal of Trauma and Disability Studies, 3(4), 286-289.
12. Ergasheva, G. (2025). POLYCYSTIC OVARY SYNDROME: A COMPREHENSIVE OVERVIEW AND CURRENT TREATMENT APPROACHES. Modern Science and Research, 4(4), 937-944.
13. Ergasheva, G. (2025). ACROMEGALY: A SEVERE NEUROENDOCRINE DISORDER WITH MULTISYSTEM MANIFESTATIONS. Modern Science and Research, 4(3), 1123-1131.
14. Ergasheva, G. (2024). THE ROLE OF CORRECTIONAL PEDAGOGY IN ORGANIZING THE EDUCATION OF CHILDREN WITH DISABILITIES. Ethiopian International Journal of Multidisciplinary Research, 11(06), 206-207.
15. Toxirovna, E. G. (2024). QALQONSIMON BEZ KASALLIKLARIDAN HASHIMOTO TIREODIT KASALLIGINING MORFOFUNKSIONAL O'ZIGA XOSLIGI. Modern education and development, 16(7), 120-135.
16. Toxirovna, E. G. (2024). REVMATOID ARTRIT: BO'G'IMLAR YALLIG'LANISHINING SABABLARI, KLINIK BELGILARI, OQIBATLARI VA ZAMONAVIY DAVOLASH YONDASHUVLARI. Modern education and development, 16(7), 136-148.
17. Эргашева, Г. Т. (2024). ОЦЕНКА КЛИНИЧЕСКОЙ ЭФФЕКТИВНОСТИ ОРЛИСТАТА У БОЛЬНЫХ ОЖИРЕНИЕМ И АРТЕРИАЛЬНОЙ ГИПЕРТЕНЗИЕЙ. Modern education and development, 16(7), 92-105.
18. Ergasheva, G. T. (2024). THE SPECIFICITY OF AUTOIMMUNE THYROIDITIS IN PREGNANCY. European Journal of Modern Medicine and Practice, 4(11), 448-453.
19. Эргашева, Г. Т. (2024). ИССЛЕДОВАНИЕ ФУНКЦИИ ЩИТОВИДНОЙ ЖЕЛЕЗЫ ПРИ ТИРЕОИДИТЕ ХАШИМОТО. Modern education and development, 16(7), 106-119.
20. Toxirovna, E. G. (2024). GIPOFIZ ADENOMASINI NAZORAT QILISHDA KONSERVATIV JARROHLIK VA RADIATSIYA TERAPIYASINING UZOQ MUDDATLI SAMARADORLIGI. Modern education and development, 16(7), 79-91.
21. ERGASHEVA, G. T. (2024). OBESITY AND OVARIAN INSUFFICIENCY. Valeology: International Journal of Medical Anthropology and Bioethics, 2(09), 106-111.

22. Ergasheva, G. T. (2024). Modern Methods in the Diagnosis of Autoimmune Thyroiditis. *American Journal of Bioscience and Clinical Integrity*, 1(10), 43-50.
23. Tokhirovna, E. G. (2024). COEXISTENCE OF CARDIOVASCULAR DISEASES IN PATIENTS WITH TYPE 2 DIABETES. *TADQIQOTLAR. UZ*, 40(3), 55-62.
24. Toxirovna, E. G. (2024). DETERMINATION AND STUDY OF GLYCEMIA IN PATIENTS WITH TYPE 2 DIABETES MELLITUS WITH COMORBID DISEASES. *TADQIQOTLAR. UZ*, 40(3), 71-77.
25. Toxirovna, E. G. (2024). XOMILADORLIKDA QANDLI DIABET KELTIRIB CHIQRUVCHI XAVF OMILLARINI ERTA ANIQLASH USULLARI. *TADQIQOTLAR. UZ*, 40(3), 63-70.
26. Toxirovna, E. G. (2024). QANDLI DIABET 2-TIP VA KOMORBID KASALLIKLARI BO'LGAN BEMORLARDA GLIKEMIK NAZORAT. *TADQIQOTLAR. UZ*, 40(3), 48-54.
27. Tokhirovna, E. G. (2024). MECHANISM OF ACTION OF METFORMIN (BIGUANIDE) IN TYPE 2 DIABETES. *JOURNAL OF HEALTHCARE AND LIFE-SCIENCE RESEARCH*, 3(5), 210-216.
28. Tokhirovna, E. G. (2024). THE ROLE OF METFORMIN (GLIFORMIN) IN THE TREATMENT OF PATIENTS WITH TYPE 2 DIABETES MELLITUS. *EUROPEAN JOURNAL OF MODERN MEDICINE AND PRACTICE*, 4(4), 171-177.
29. Эргашева, Г. Т. (2024). Эффект Применения Бигуанида При Сахарным Диабетом 2 Типа И Covid-19. *Research Journal of Trauma and Disability Studies*, 3(3), 55-61.
30. Toxirovna, E. G. (2024). QANDLI DIABET 2 TUR VA YURAK QON TOMIR KASALLIKLARINING BEMOLARDA BIRGALIKDA KECISHI. *ОБРАЗОВАНИЕ НАУКА И ИННОВАЦИОННЫЕ ИДЕИ В МИРЕ*, 38(7), 202-209.
31. Эргашева, Г. Т. (2024). СОСУЩЕСТВОВАНИЕ ДИАБЕТА 2 ТИПА И СЕРДЕЧНО-СОСУДИСТЫХ ЗАБОЛЕВАНИЙ У ПАЦИЕНТОВ. *ОБРАЗОВАНИЕ НАУКА И ИННОВАЦИОННЫЕ ИДЕИ В МИРЕ*, 38(7), 219-226.
32. Эргашева, Г. Т. (2024). СНИЖЕНИЕ РИСКА ОСЛОЖНЕНИЙ У БОЛЬНЫХ САХАРНЫМ ДИАБЕТОМ 2 ТИПА И СЕРДЕЧНО-СОСУДИСТЫМИ ЗАБОЛЕВАНИЯМИ. *Образование Наука И Инновационные Идеи В Мире*, 38(7), 210-218.
33. Tokhirovna, E. G. (2024). CLINICAL AND MORPHOLOGICAL ASPECTS OF THE COURSE OF ARTERIAL HYPERTENSION. *Лучшие интеллектуальные исследования*, 12(4), 234-243.
34. Tokhirovna, E. G. Studying the Causes of the Relationship between Type 2 Diabetes and Obesity. Published in *International Journal of Trend in Scientific Research and Development (ijtsrd)*, ISSN, 2456-6470.
35. Toxirovna, E. G. (2024). ARTERIAL GIPERTENZIYA KURSINING KLINIK VA MORFOLOGIK IZHATLARI. *Лучшие интеллектуальные исследования*, 12(4), 244-253.
36. Эргашева, Г. Т. (2024). НОВЫЕ АСПЕКТЫ ТЕЧЕНИЕ АРТЕРИАЛЬНОЙ ГИПЕРТОНИИ У ВЗРОСЛОГО НАСЕЛЕНИЕ. *Лучшие интеллектуальные исследования*, 12(4), 224-233.
37. Эргашева, Г. Т. (2024). ФАКТОРЫ РИСКА РАЗВИТИЯ САХАРНОГО ДИАБЕТА 2 ТИПА. *ОБРАЗОВАНИЕ НАУКА И ИННОВАЦИОННЫЕ ИДЕИ В МИРЕ*, 36(5), 70-74.
38. Эргашева, Г. Т. (2024). ОСЛОЖНЕНИЯ САХАРНОГО ДИАБЕТА 2 ТИПА ХАРАКТЕРНЫ ДЛЯ КОГНИТИВНЫХ НАРУШЕНИЙ. *TADQIQOTLAR. UZ*, 30(3), 112-119.

39. Эргашева, Г. Т. (2023). Исследование Причин Связи Диабета 2 Типа И Ожирения. *Research Journal of Trauma and Disability Studies*, 2(12), 305-311.
40. Tokhirovna, E. G. (2024). Risk factors for developing type 2 diabetes mellitus. *ОБРАЗОВАНИЕ НАУКА И ИННОВАЦИОННЫЕ ИДЕИ В МИРЕ*, 36(5), 64-69.
41. Toxirovna, E. G. (2024). QANDLI DIABET 2-TUR VA O'LIMNI KELTIRIB CHIQUARUVCHI SABABLAR. *Лучшие интеллектуальные исследования*, 14(4), 86-93.
42. Tokhirovna, E. G. (2023). Study of clinical characteristics of patients with type 2 diabetes mellitus in middle and old age. *Journal of Science in Medicine and Life*, 1(4), 16-19.
43. Toxirovna, E. G. (2024). GIPERPROLAKTINEMIYA KLINIK BELGILARI VA BEPUSHTLIKKA SABAB BO'LUVCHI OMILLAR. *Лучшие интеллектуальные исследования*, 14(4), 168-175.
44. Toxirovna, E. G. (2023). QANDLI DIABET 2-TUR VA SEMIZLIKNING O'ZARO BOG'LIQLIK SABABLARINI O'RGANISH. *Ta'lim innovatsiyasi va integratsiyasi*, 10(3), 168-173.
45. Saidova, L. B., & Ergashev, G. T. (2022). Improvement of rehabilitation and rehabilitation criteria for patients with type 2 diabetes.
46. Эргашева, Г. Т. (2023). Изучение Клинических Особенности Больных Сахарным Диабетом 2 Типа Среднего И Пожилого Возраста. *Central Asian Journal of Medical and Natural Science*, 4(6), 274-276.
47. Toxirovna, E. G. (2023). O'RTA VA KEKSA YOSHLI BEMORLARDA 2-TUR QANDLI DIABET KECHISHINING KLINIKO-MORFOLOGIK XUSUSIYATLARI. *ОБРАЗОВАНИЕ НАУКА И ИННОВАЦИОННЫЕ ИДЕИ В МИРЕ*, 33(1), 164-166.
48. Ergasheva, G. T. (2022). QANDLI DIABET BILAN KASALLANGANLARDA REABILITATSIYA MEZONLARINI TAKOMILASHTIRISH. *TA'LIM VA RIVOJLANISH TAHLILI ONLAYN ILMIY JURNALI*, 2(12), 335-337.
49. Ergasheva, G. (2024). METHODS TO PREVENT SIDE EFFECTS OF DIABETES MELLITUS IN SICK PATIENTS WITH TYPE 2 DIABETES. *Журнал академических исследований нового Узбекистана*, 1(2), 12-16.
50. ГТ, Э., & Саидова, Л. Б. (2022). СОВЕРШЕНСТВОВАНИЕ РЕАБИЛИТАЦИОННО-ВОССТАНОВИТЕЛЬНЫХ КРИТЕРИЕВ БОЛЬНЫХ С СД-2 ТИПА. *TA'LIM VA RIVOJLANISH TAHLILI ONLAYN ILMIY JURNALI*, 2(12), 206-209.
51. Toxirovna, E. G. (2025). YURAK-QON TOMIR TIZIMI KASALLIKLARIDA BEMORLAR PARVARISHINING O'ZIGA XOSLIGI. *Modern education and development*, 20(2), 38-46.
52. Ergasheva, G. (2025). PECULIARITIES WHEN ACCOMPANIED BY HYPOTHYROIDISM AND IODINE DEFICIENCY IN PATIENTS WITH ADRENAL GLAND PATHOLOGY. *Modern Science and Research*, 4(2), 1133-1140.
53. Tokhirovna, E. G. (2024). Relationship of the Functional States of the Thyroid and the Reproductive System in Women under Iodine Deficiency. *Journal of Science in Medicine and Life*, 2(6), 89-94.